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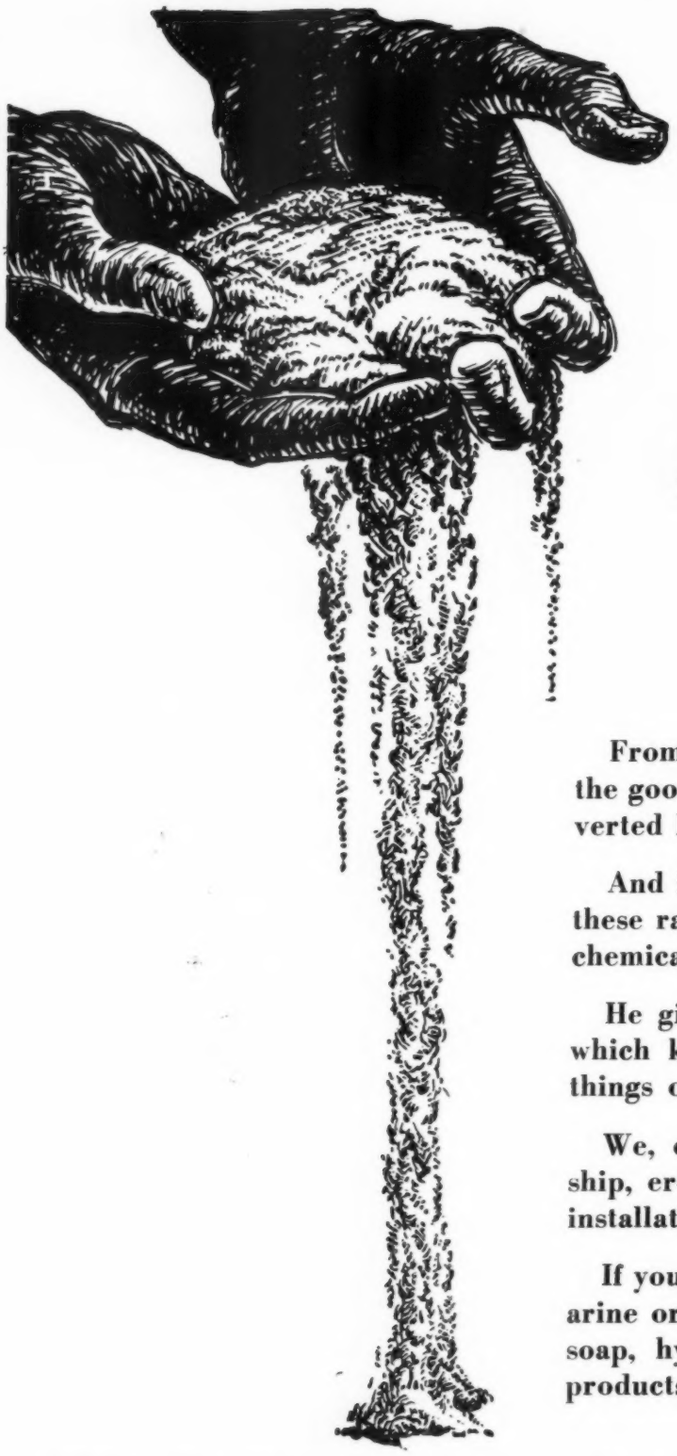

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WORLD CROPS

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THIS MONTH'S COVER

Native reserve land at Mdizini, in the Kingwilliamstown district of the Cape Province. Native-owned stock are in the foreground while native huts are on the ridge at the back.

(Photo: State Inf. Office, Pretoria)

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Editorial Comment

FAO

FOR the last five years and in fact from its foundation immediately after the last war, FAO, or to give it its full title the Food and Agriculture Organisation of the United Nations, has made its headquarters in Washington. It has for a long time been accepted that this was only a temporary arrangement and it was early envisaged that ultimately it would be sited somewhere in Europe. Eventually Rome was selected, and it is now announced that the transfer to its new permanent seat will be effected early next year. The choice of Rome seems particularly appropriate inasmuch as it was formerly the site of the predecessor of FAO, the International Institute of Agriculture, founded 30 years ago as the result of the efforts of David Lubin, who conceived the idea of an international institution charged with the duties of co-ordinating and advising on agricultural developments throughout the world. Insufficiently provided with funds and resources, it must be admitted that it only inadequately fulfilled the ideals of its progenitor; nevertheless it did succeed in accomplishing a fair amount of useful work despite these handicaps. Its existence terminated when Italy entered the second world war as an ally of Germany.

Incidentally, steps have been taken to designate the library of FAO, when it is consolidated and established in its new home in Rome, 'The David Lubin Memorial Library.' All will agree that this is a fitting tribute to the foresight and leadership of a man who was before his time in the field of international co-operation.

At the ninth meeting of the Council of FAO held in Rome in May last, under the chairmanship of Lord Bruce of Melbourne, the financial and administrative arrangements involved in making the transfer were discussed and approved. At the same time the Council brought to the attention of member Governments the need for stronger financial support if the organisation is to fulfil its purpose.

It cannot be denied that in some quarters FAO has been severely criticised and disappointment has been expressed that it has not to a greater extent fulfilled the hopes entertained concerning it. Nevertheless, bearing in mind that it is an organisation of 63 independent countries and that its pace is dictated by the limits imposed by its members, its records number some substantial achievements. The numerous conferences and meetings which it has organised have produced valuable results. The visits paid by its Director-General to 18 different countries are considered by its Council to have assisted to produce 'the kind of understanding at policy level which can only be reached by personal contact.' Its publications are noteworthy for their clarity of exposition and excellence of presentation, while its statistical summaries are of high and undoubted value.

One difficulty is the risk of overlapping with the numerous other organisations of UNO engaged in parallel activities and the Council has wisely laid stress on the necessity of close co-ordination in this regard and on limitation of aims.

Let us hope that the additional resources that FAO needs for its programmes may be forthcoming in adequate degree, and that in its new home it will increasingly justify in the long run the hopes which inspired its foundation.

The new locust threat

THE news that a fresh locust threat to large parts of Africa and south-western Asia is imminent comes as a considerable shock. After the experiences of the war and the ample proof then given that once the areas where swarming is liable to occur are known it is possible by taking early remedial measures to check the swarms and prevent the occurrence of major catastrophes, it was hoped that at long last this age-old menace was in a fair way to being adequately controlled if not entirely removed.

Unfortunately, these hopes have signally failed to materialise and once more the world is confronted with a position rivalling in magnitude and seriousness any of the outbreaks of the past.

The threat comes from the desert locust (*Schistocera pallens*) and took its rise in the vast sandy desert of Rub al Khali in eastern Arabia, where in the winter of 1948-49 abnormal rains created conditions very favourable to the multiplication of the insects and, in the absence of checks at the outset, they spread in the ensuing summer months to Persia, thence to the Indo-Pakistan region and to the Yemen and the Aden Protectorate; last winter they crossed the Red Sea and appeared in Somaliland, Eritrea and Abyssinia. A rapid increase in swarms has followed and the present threat has developed. A full campaign will involve the employment of thousands of men and hundreds of lorries, the use of large quantities of insecticides and expenditure estimated at more than £1,000,000 per annum over a period of several years.

It is a chastening reflection that these events have been foreseen for some time and that the present position appears to be due to failure to provide adequate resources to enable the threat to be combated at the outset. Most of the requisite scientific knowledge is available; the International

Locust Control set up during the war demonstrated its ability to handle a parallel situation, provided adequate resources were forthcoming. After the war the great organisation that had been built up was greatly curtailed and its activities concentrated into a much smaller organisation known as the Desert Locust Survey with headquarters at Nairobi. A number of the scientists engaged, who possessed unrivalled knowledge of the conditions and of the problem, were allowed to be diverted to other activities, while the rest were expected to survey the whole of eastern Africa and Arabia and to institute effective control measures with the very limited resources at their command at any point where danger threatened in this vast stretch of some of the most difficult country in the world. Is it any wonder that they failed?

The position appears to be one more example of the consequences of official unwillingness to heed and accept the warnings of the scientist, and to provide adequate facilities for the tasks he is required to undertake. Locusts are, it is true, an international problem and the financing of a locust control scheme therefore presents particularly difficult problems; nevertheless the fact remains that if a tithe of the money which has been poured out in attempts, for example, to grow groundnuts by untried methods in unfavourable surroundings, had been expended on locust control the present threat to the existence of millions would not, in all probability, have materialised.

Fungicides

IT was until comparatively recently something of a reproach that, while considerable progress had been made in developing new forms of insecticides, parallel advances had not been achieved in the field of fungicides. The traditional remedies of Bordeaux or Burgundy mixture and lime sulphur wash held the field almost unchallenged during the time before the war when insecticide manufacturers were making great strides with derris and pyrethrum to supplement and replace the older arsenicals and, during and after the war, the array of organic chemicals of which DDT was the first.

Today, however, the scene has definitely changed. Lime sulphur wash has steadily lost ground to other preparations, usually containing the sulphur in an organic combination and in particular to the thio-carbamates, while Bordeaux and Burgundy mixtures have similarly tended to be replaced by copper organic compounds.

Probably the development of the thio-carbamates is the most important feature, and in the U.S.A. particularly they have made great strides. Numerous compounds are now on the market containing dithio-carbamic acid in combination with various metals such as zinc, iron, sodium and manganese and linked to a variety of organic radicles. Copper compounds are developing on similar lines; for example a compound which is reported from the U.S.A. to be giving excellent results against tomato anthracnose is copper quinolinate, marketed under the name Bioquin 1.

In the United Kingdom similar developments are in progress. Organo mercurial seed dressings are already well established, for example, and other compounds are making their appearance.

Obviously after getting off to a rather slow start, new and efficient forms of fungicides are rapidly increasing in number, and with the passing of time there seems no reason to doubt that in this field, too, the chemist will achieve the commanding position which he has already reached in connection with insecticides.

Manuring rice

THE varying response of rice soils to manuring has for long been a perplexing problem and much of the experimental evidence available from different lands has been conflicting and inconclusive. Often the response to fertilisers has been unexpectedly small, while in some countries there is a maximum yield at a rather low level and beyond this manuring does not increase the crop. This is particularly surprising since over large areas in Asia rice crops have been taken off the same lands annually for centuries.

In his presidential address to the British Association a year ago Sir John Russell mentioned some developments in this direction which have occurred recently in Japan, based on Pearsall's observation that on waterlogged soils an oxidation reduction potential layer exists a short distance below the soil surface. On the surface layer oxidation proceeds more or less normally, but below it the reaction is one of reduction. In the reduction zone nitrates are reduced ultimately to free nitrogen which escapes.

Sulphate of ammonia applied to the surface of wet paddy soils at or before transplanting is quickly oxidised to nitrates and washed down to the lower layers, where it is reduced to free nitrogen and is lost. When, however, it is pushed down into the reduction region, it remains there unchanged until the plant can take it up. If, on the other hand, nitrates are applied to the surface layer after the crop is established and making active growth, they can be absorbed by the plant before they reach the reducing layer.

The Japanese were quick to realise the implications, for it not only offered an explanation for certain observed reactions, but suggested new methods of applying fertilisers to the crop. Japanese official recommendations now state that loss of ammonium-nitrogen through oxidation-reduction in paddy fields can be prevented to a great extent if

nitrogenous fertilisers are applied deep in the soil. They state that nitrogenous fertilisers should be thoroughly mixed with the soil and the field be irrigated within three or four days after application of fertilisers, and that irrigated fields should be drained before fertilisers are applied.

Experiments in Louisiana have shown that placing the fertiliser 2 in. below the seed increased the yield of rice by 8½ bushels per acre over the method of drilling directly with the seed, while reports from Brazil state that when the fertiliser was placed in furrows parallel to the rice drills, there was a significant response to ammonium sulphate, but not to superphosphate.

It is early to assess the value of this work, but should future experience confirm the value of this method of fertiliser application, a very great and important advance will have been made towards the attainment of higher yields as a result of a new method of applying fertilisers, based on scientific observation.

Molybdenum

TRACE elements have now become a topic of current interest to farmers almost the world over. It is widely known that the action of the major plant food elements, nitrogen, phosphorus and potash, may be conditioned by the presence of small quantities of boron, manganese, copper, zinc, cobalt and, last but not least, molybdenum. If any of them are deficient plant and animal growth may be adversely affected, while the same thing may happen if they are present in excessive quantities. We learn from the report of the team of British fertiliser specialists who recently visited the U.S.A. and whose report is reviewed in this issue, that fertiliser manufacturers in that country are now beginning to include in compounded manures for use in different localities, trace elements which are known to be deficient there. In Australia the absence of trace elements has been shown to be responsible for the apparent infertility of large tracts of land, while in the United Kingdom the importance of trace elements has been thrown into high relief as the result particularly of the work of Wallace and his co-workers at Long Ashton.

Of all the trace elements the most intriguing and perhaps most baffling is molybdenum, which has lately come into prominence partly by reason of the extremely small amounts which may be involved (*e.g.* one part of molybdenum in one thousand million parts of water may be enough to influence growth), while, on the other hand, it may be tolerated in higher concentrations than almost any other micronutrient. Particularly interesting, however, is the part which it has been found to play in the nitrogen cycle. It influences the assimilation of nitrates by plants, the fixation of nitrogen from the air both by nodule-forming bacteria in leguminous plants and also by free-living organisms of the azotobacter type, and denitrification.

In South Australia failure to establish subterranean clover has been traced to unavailability of molybdenum for the root nodule organisms. The importance of azotobacter in the soil is still regarded as questionable in many quarters, but it has been shown that the organism has a great need for molybdenum and it seems possible that this may prove a partial clue to its functions and importance.

The further elucidation of the nitrogen cycle is one of the major fundamental problems which must be solved if a fully scientific basis for farming is to be developed. That its importance is appreciated in scientific circles was shown when a whole session of the chemistry section of the British Association in Newcastle last year was devoted to its consideration. The discovery that its course can be materially modified by the presence or absence of small traces of this element may be of considerable significance.

Farm face-lifting

OUR cousins in America are adepts at the telling phrase and the spectacular demonstration, and the attention of our many readers will be caught by the article which appears under the title of ' Farm Face-Lifting ' in other pages of this issue.

The term has been devised to describe the one-day soil conservation demonstrations which have now attained considerable popularity in the U.S.A. Readers may remember that we alluded briefly to the subject in these columns some months ago, and this article, which is based on material supplied to us by the Soil Conservation Branch of the United States Department of Agriculture, discusses the origin and objects of these displays and describes how they are run.

Briefly the underlying idea is to perform in the space of a nine-hour day all the operations essential to the rehabilitation of a badly-eroded farm property, and to make it a public occasion to which the whole countryside will be attracted.

Obviously it is not an economic way of doing the job; obviously also such demonstrations would be worse than useless if the initial operations were not followed up and the improvements instituted were not maintained in the years that follow. To ensure this has been one of the main difficulties that had to be faced. Moreover, the possibility of undertaking them at all involves the assumption that there is already sufficient public appreciation of the urgent necessity for conservation, since they depend on a large measure of co-operation from farmers and official authorities, much voluntary assistance and the donation or loan of materials and

machinery. Given all this they appear to be meeting with considerable success and the spectacular appeal to the popular imagination is well-nigh irresistible. The danger is that if all these criteria are not adequately fulfilled they might do more harm than good.

Human nature is such that, provided the movement gets off to a good start, the results are cumulative in geometrical progression—in fact there is a snowball effect. To us it appears that the translation of the idea to other parts of the world where conditions are favourable is well worthy of consideration, particularly in the case of less developed and highly impressionable communities; although here a note of warning seems appropriate, to the effect that it is essential that in carrying them out the full co-operation and assistance of the community itself must be ensured. If this is lacking, and they are undertaken solely through official agencies, they may share the fate of so many other demonstrations and be regarded as yet another example of the inexplicable manoeuvres of government, which have no sort of real bearing on the daily life of the community.

Feeding pine seedlings

A SURVEY of the position of research in regard to forest nursery nutrition has been provided by Dr. E. M. Crowther in the Rothamsted Annual Report for 1949, in which much information previously published in scattered fashion has been brought together. If an obvious play upon words may be permitted, we can now begin ' to see the wood for the trees ' for the first time. Some of the earlier work had, unfortunately, become associated with the humus versus chemicals controversy, but following the setting up of a Sub-Committee on Nutritional Problems by the Forestry Research Advisory Committee in 1944 this confusing drift towards extremism and prejudice has been removed. Early work based on an inadequate number of uncritically designed experiments at a pine nursery in Dorset had led to the conclusion that healthy establishment depended upon the supply of composts, and that increases in the supply of available nutrients played a relatively insignificant part. From this conclusion, the thesis was developed that nutrition is dominated by the symbiotic association of mycorrhizal fungi in the plant roots. The humus school, always quick to seize upon any apparent failure of fertilisers, endeavoured to extend this hypothesis to cover the general nutrition of farm crops as well !

It is now, however, abundantly clear from further work at Wareham and at other centres, that the composts originally used contained more nutrients than did the fertiliser applications with which they were compared, a factor of extreme importance, since the soil to which they were added was itself very deficient in them.

Recent experiments have shown that *adequate* fertiliser treatment can produce more vigorous seedlings than can composts alone, while variations in the effects of different composts are correlated to their contents of major nutrients.

This does not mean, however, that the use of composts in rearing seedlings is unnecessary, nor that it is sufficient to rely solely upon fertilisers. ' In fact, the combination of compost and fertilisers commonly gave larger plants than either kind of manure alone.' On the poor soils that are mainly used for this work the physical improvements in soil structure that follow compost dressings probably have important effects ; moreover, slow-acting nitrogenous fertilisers appear to be preferable to quick-acting forms since they compare to the steady, long-term demands of tree growth ; when composts and fertilisers are used in conjunction the nitrogen in the compost can act as a delayed supplement to the inorganic nitrogen of the fertiliser. In the period 1944-1949, no evidence has emerged to prove that specific microbiological benefits are derived from the use of composts.

The real importance of the mycorrhizal fungi which attach themselves to conifer root systems has still to be determined. What has been clearly settled is that proper and adequate use of fertilisers in rearing seedling trees does not inhibit or endanger the subsequent growth of the tree when it is transplanted. It follows that, *if* the symbiotic functions of these fungi are truly important, the use of fertilisers is not antagonistic to them. Indeed, Dr. Crowther goes so far as to propound an alternative theory for the mycorrhizal phenomenon. He suggests that instead of being a contributory means for feeding the tree, these root inhaling fungi may be no more than a consequence of satisfactory nutrition in terms of major plant food inasmuch as the fungi are parasites and acquire their own food from the surplus carbohydrate of the tree's roots. This is in closer accord with the results of the 1944-1949 experiments than is the earlier hypothesis, that good nutrition depends upon, and follows, the attachment of mycorrhizal fungi.

CORRESPONDENCE

The columns of 'WORLD CROPS' are open to correspondence and the Editor welcomes letters from readers supplementing and commenting on articles or on other matters within our sphere. Limitations of space may occasionally necessitate the abridgement of letters.

Barley and Brewing

Characteristics of British Malting Barleys

H. HUNTER, M.A., D.Sc.

Beer is the most popular beverage in many lands; the raw material most usually employed in brewing is malted barley, and in a trilogy of articles in this and succeeding issues we shall review the production of barley for malting, the malting process and the conversion of malt into beer in their various aspects today. The first of the series is by Dr. H. Hunter, and in it he describes the characteristics of barley suitable for malting, and the progress made in developing improved types during recent years.

THE growing appreciation of the economic importance of ' quality ' in agricultural products, however this term may be defined, is general, and but for exigencies arising from recent hostilities, when the yield of the crops, regardless of other features, was a paramount necessity in the British Isles, this aspect of agricultural production would undoubtedly have received considerably greater attention. Fortunately, under conditions of reduced national stringency this important feature is again under close scrutiny, and a welcome indication of the change is the increasing appreciation of qualitative differences existing even in superior varieties of all classes of crops, and the consequent need of integrating their relative value from this angle as well as from that of yield alone.

In the past, cereals as sources of human food have claimed particular attention from the qualitative angle, but changes in human necessities and tastes and in methods of processing are constantly arising, and entail an amplification of the position already secured or, at times, an entirely fresh orientation of objectives. Amongst millers today, for example, there is a demand for wheat grain which not only yields a high proportion of flour to bran, an obvious and generally accepted criterion of milling value, but possesses good sieving qualities, thus facilitating the final operations of milling and thereby increasing the potentiality of flour mills. Still more important developments, from the nutritional point of view, are the investigations that have been undertaken with a view to determining the vitamin contents of individual varieties. Similarly, in oats, successful attempts have been made to increase their quality by reducing the proportion of husk, the least valuable portion of the oat grain, whilst the value of rye for crisp bread manufacture has been enhanced by the advent of varieties with higher soluble protein contents, combined with such desirable agricultural attributes as good grain yield and a high degree of resistance to ' lodging,' that is to the laying of crops by adverse weather conditions. ' Quality ' in malting barley similarly presents specific problems, but with this highly important difference that malting involves the partial growth of the grain, a biological process which presents problems that do not arise in the utilisation of other cereals.

Fundamental requisites

In barley intended for malting high percentage and a high speed of germination are fundamental requisites. Second to these and, indeed, closely related thereto, grain offered for malting should exhibit good 'condition'; that is, its moisture content should be such as not to impair keeping quality. At the same time good condition provides a natural guarantee that the initial stages of germination have not commenced.

High-class malting grain possesses sharply defined physical features; it has, first, a good colour and bloom, and the skin is finely reticulated as evidence of complete ripeness, while the interior is 'mealy.' In contrast, grain of inferior quality and unripe grain of even superior malting varieties has a smooth, rather loose skin, and the interior exhibits a dark, 'steely' surface when cut across (Figs. 1-4). These are the outstanding features of difference, but there are many others of a more ancillary character.

Between samples of superior and inferior malting quality it is not difficult to discriminate on appearance alone, but between those of intermediate quality differences in value are not so readily established.

Constituents of barley

The constituents of barley grain may be considered under four headings:

(1) Starch and very small quantities of sugar; which amount to 65% of the grain, and are the most valuable to the brewer;
(2) Proteins and similar nitrogen compounds; amounting to 9 to 12% of the grain;
(3) Cellulose, which forms the skeleton of the grain; amounting to 10%, and
(4) Ash, fats, etc.; which total 1 to 2%.

Although forming only approximately 9 to 12% of the grain, the proteins are important in malting grain, for as the percentage of protein increases the quantity of the valuable starch decreases and *vice versa*. Moreover, although limited quantities of soluble proteins are useful in the final wort as a basis of flavour and as food for the yeast used during fermentation of the wort, their presence in excess is deleterious to the keeping quality and 'life' of the final beer.

Nitrogen content as an index of quality

Within the last half-century the application of more scientific methods of operation in malting and brewing, including those relating to the chemical composition of barley grain, have demonstrated that grain of high malting quality is characterised by a relatively low total nitrogen content and, inversely, that of inferior quality by a high total nitrogen content. The value of the total nitrogen content as an index of malting quality has been amply confirmed by very many actual malting and brewing tests, and in a much wider sense by general malting and brewing experience. At the same time it may be noted that amongst native varieties, some of them of hybrid origin, cases have been met with in which the grain, although exhibiting a relatively low total nitrogen content does not yield a correspondingly high extract on brewing. Fortunately such forms may be regarded as exceptions, but the very possibility of their occurrence, whilst interesting genetically as indicating the existence of factors other than those already examined, emphasises the necessity of determining all aspects of the value of new varieties before they are finally introduced into general cultivation. Again, the varieties of Danish origin such as Kenia, Maja, etc., many of which are now appearing in general cultivation in the British Isles, include some which, although generally higher in total nitrogen than native barleys grown under comparable conditions, appear to yield higher quantities of extract than the nitrogen figure portends, while there are also indications that for an equal nitrogen figure the amount of permanently soluble nitrogen formed in the wort is lower than in native barleys. Indeed, qualitatively and, as will be shown later, in morphological characters, the Scandinavian series of varieties exhibit features not met with formerly.

As a final qualification to the use of the total nitrogen figure as an index of malting value, since the proportion of endosperm to the total grain is greater in large, well-fitted grain than in smaller grains and the large grains of a sample of any one variety tend to show lower total nitrogen than the smaller grains of the sample, grain size must also be included in any qualitative evaluation. Dr. L. R. Bishop has combined the various factors influencing the final extract in a prediction formula using a constant for each variety. Thus, for Plumage-Archer: E (extract in brewers' lb. per quarter of dry malt) $= 108.3 - 10.5 \times N + 0.20 \times G$, where N = percentage of nitrogen in dry barley and G = weight per 1,000 dry grains in grams.

The improvement of malting barley

The improvement of barley in its widest aspect is inevitably a complex matter, since, while it is possible to secure high malting quality, or high grain yield, or a high degree of resistance to 'lodging,' as separate attributes in individual varieties, the combination of these and other desirable attributes in one variety is not so readily obtained. Thus in breeding it is often necessary to accept a compromise as a stepping stone towards the visualised objective.

Strength of straw, which is the basis of resistance to 'lodging,' may be quoted as an apposite example; amongst varieties native to the British Isles, Spratt was for a long time the variety exhibiting the highest degree of resistance to 'lodging.' When Spratt was crossed with Archer, one of the segregates arising from the cross was a form which, because of its good straw combined with other desirable features, was ultimately introduced into general cultivation as Spratt-Archer. But the new barley, while superior to the parent Archer in resistance to 'lodging,' was not equal to the other parent, Spratt, in this respect, while the segregates that equalled or surpassed Spratt in the expression of this attribute were all deficient in malting quality and in other features.

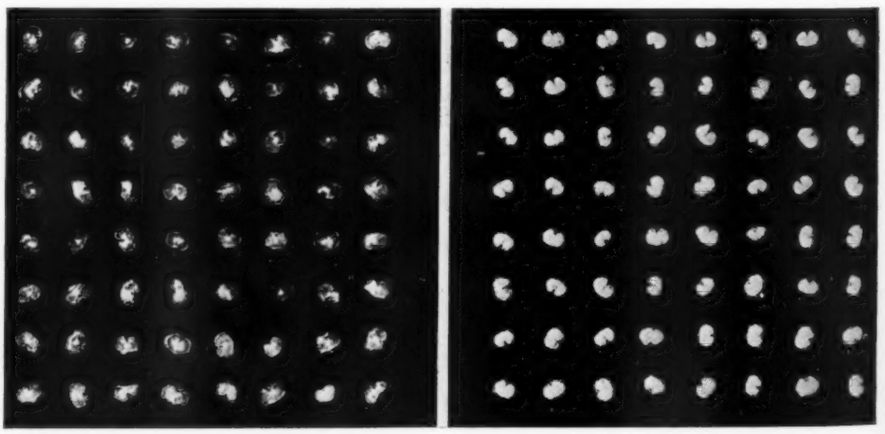


Fig. 1 (*left*) **shows the 'steely' section, loose skin and indifferent filling of a poor malting sample of barley. Fig. 2** (*right*) **shows the 'mealy' section, close skin and good filling of a high quality sample**

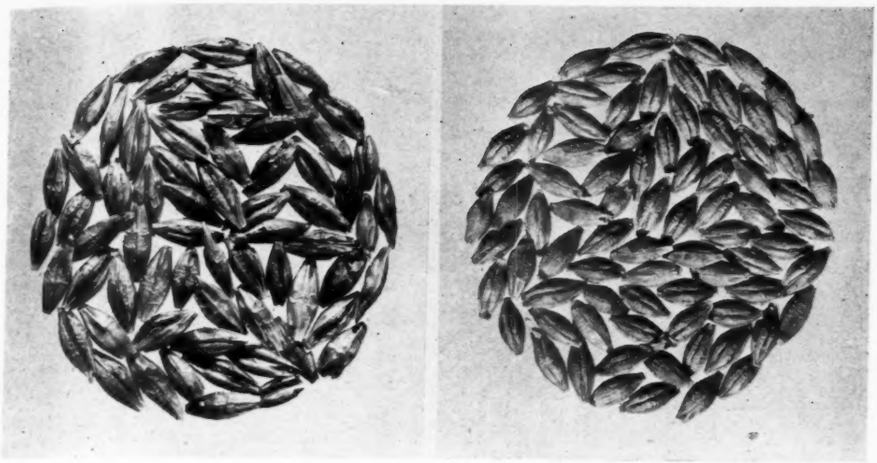


Fig. 3 (*left*) **shows a sample of inferior malting barley; the indifferent filling and loose skin are in marked contrast to the well-filled ventral groove of the grain and finely reticulated skin of the high-class sample, fig. 4** (*right*)

Early Danish investigations

A series of investigations commenced in Denmark about 1880 by the Royal Danish Agricultural Society and carried out by that body in collaboration with the Carlsberg Brewery, Copenhagen, was probably the first attempt of its kind to deal with the many-sided problem of malting barley production. The Danish investigations were continued for several years and comprised tests conducted in the field, in conjunction with determinations of quality made on the malt produced from the grain grown on the experimental plots, and, finally, on the resulting beer. In the main the investigations were directed to determining the variety best suited to Danish agricultural conditions and brewing demands, and it is interesting to note that in these respects two English varieties, Prentice and Goldthorpe, were ultimately found superior to the Danish varieties and many other foreign sorts included in the trials. Goldthorpe was proved to possess the highest malting quality of any variety examined, but it was so much inferior in yield of grain to Prentice that the value of its superior quality could only compensate for this deficiency at a considerably higher commercial figure than was obtainable. Prentice, on the other hand, combined high grain yielding capacity and a sufficiently high malting quality to satisfy both agricultural and brewing requirements. As a result of these findings Prentice became the predominant variety in Denmark for a number of years.

Irish investigations

About twenty years later a similar series of investigations was commenced in Ireland under the direction of the Irish Department of Agriculture and Technical Instruction, in collaboration with Messrs. A. Guinness, Son & Co. Ltd., the Dublin brewers. These, as in Denmark, consisted of field trials conducted in all barley-growing districts, and of malting and brewing trials carried out on the produce of all the experimental field plots. Archer and Goldthorpe were again compared with the indigenous and imported varieties that were then in use in Ireland with results that were identical to those obtained in Denmark, and Archer quickly became the predominant variety in Ireland as Prentice had two decades earlier in Denmark.

The similarity of the results obtained in the two countries, particularly the superiority of Archer, became more striking when it was discovered that Prentice, as the barley was known in Denmark, was in reality the well-known English variety, Archer. A quantity of seed of Archer had been imported in Denmark through an English seedsman named Prentice and the variety became known in that country by his name. In Denmark Prentice underwent a series of selections, and the best of these were ultimately issued with the name of the particular station at which they originated prefixed to the name of Prentice, thus Tystofte Prentice, Lyngby Prentice. In Sweden similar selections resulted in the introduction of a form named Princess Prentice.

There were, however, two qualifying features to the continued acceptance of Archer—its resistance to 'lodging' was limited, particularly on more fertile soils, and it was relatively late in ripening, a feature of considerable consequence in districts of heavy rainfall, and in Denmark and other north European countries where the date of sowing is later than in many areas in this country.

These objections were surmounted in Ireland by the introduction in 1914 of a variety called Spratt-Archer, which was obtained by crossing a line of Archer denominated Irish Archer 1 and Spratt, a barley with a high degree of resistance to 'lodging' but of generally inferior malting quality. Spratt-Archer proved superior in yield to Archer by 10% and has a higher degree of resistance to 'lodging'; its malting quality, moreover, is somewhat higher than Archer, and it is also slightly earlier in ripening.

English breeding results

Shortly before the introduction of Spratt-Archer, Plumage-Archer—also a hybrid variety—appeared. Plumage-Archer, derived from the cross Plumage and Archer, combines the very high malting quality of the Goldthorpe types with the shorter straw of Archer, and is at the same time free of the liability of the ear to fall off the straw when ripe, a defect to which Goldthorpe was particularly prone. Plumage-Archer exhibits a strong partiality to the rather heavier and more fertile barley soils, although it succeeds on lighter soils in districts of ample rainfall. Spratt-Archer, on the other hand, exhibits a high adaptability to both types of soil, and is equally successful under conditions of light or heavy rainfall.

Under comparable levels of soil fertility the yield of grain and the malting quality of the two varieties are approximately equal, although in appearance Plumage-Archer is often the more attractive barley. The extent to which Spratt-Archer and Plumage-Archer have met British agricultural and brewing requirements is indicated by a recent varietal survey of England and Wales which shows that of a sample of 136,000 quarters drawn from the two countries in 1946, 45% was Spratt-Archer and 16.5% was Plumage-Archer.*

Later Danish work

The problem of arriving at high grain yield combined with good quality and resistance to 'lodging' associated, if possible, with relative earliness in ripening has been solved for Danish conditions by the introduction of a series of hybrid varieties obtained by crossing a barley named Gul, which was extracted from a 'land' race indigenous to the island of Gotland, and another selection named Binder, which originated from the more widely known mid-European Moravian barley, Hanna. For Danish agricultural conditions, where barley commonly follows

*'Malting Barley in England and Wales. A Survey of the Distribution of Varieties . . .' Pure Seed Co. Ltd., London, July 1947.

sugar-beet in the crop rotation, resistance to ' lodging ' is fundamentally important, since the sugar-beet crop there is usually manured heavily. The Danish hybrids, of which Kenia and Maja were the first to be introduced, are characterised by straw of entirely different character to that of earlier Danish or English barleys, for it is short and, although fine, extremely resilient and highly resistant to ' lodging ' even on the most fertile soils.

Danish and British varieties compared

It is difficult to reach an assessment of the yield and malting quality of the now extended number of varieties of the Kenia and Maja type in terms of native British varieties, since the latter demand a lower level of soil fertility to obviate ' lodging,' and any comparison is thus weighted in favour of varieties of inferior potential yield. Nevertheless, for the moment it is fair to say that under such conditions Kenia and Maja, etc., are high yielding types and give a slightly higher total nitrogen content and almost invariably a lower 1,000-grain weight than the predominantly native sorts. But as a set-off to the normally higher nitrogen it must also be stated that these barleys produce a higher extract than native varieties with the same nitrogen figure, and there are the additional indications that some at least of the Kenia series yield less soluble nitrogen in the final extract or wort.

Yield and malting quality

In contradiction of a once firmly held conviction that high grain yield and good malting quality are incompatible varietal attributes, it is interesting to note the extent to which such a combination is exemplified in both Plumage-Archer and Spratt-Archer, and even more so in the Kenia series. The same general association of high yield and quality is exhibited in the Irish experimental results where, viewing the yield of Archer over a period of 18 years, the average yield of grain was 185 stones per acre and the average total nitrogen 1.54%, whereas in the three seasons producing the highest yield, namely 204, 213 and 224 stones per acre respectively, the corresponding nitrogen figures were 1.48, 1.55 and 1.47%, whilst the lowest yield of the series was 162 stones per acre and the total nitrogen content 1.76%.

But it would be unwise to assume from this that where the total nitrogen is low the yield must be correspondingly high. Indeed, in the series of trials just mentioned the lowest nitrogen figure, 1.26% in 1913, was associated with a yield of 185 stones, which is identical with the average yield for the whole series for 18 seasons. An explanation of this apparent contradiction probably lies in the fact that there are two very distinct phases of development in barley as in other cereals—one, which may be termed the vegetative phase, during which period the framework of the plant (including particularly the tillers) increases in number and size; and the other entirely concerned with changes involving seed formation. The weather during these two separate periods may be favourable to both phases, in which case optimum results will follow; on the other hand, it may be favourable in the first phase and unfavourable in the second phase, when high yields of moderate quality will be obtained, or unfavourable in the first phase and favourable in the second, when lower yield with high quality will result.

Further evidence against the invariable association of high yield and high malting quality is provided by the hybrid form Archer-Goldthorpe. This barley is characterised by a short, very stiff straw and, while inferior to Archer in yield of grain, is usually superior in malting quality; thus Archer-Goldthorpe as a variety provides one of the exceptions so often met with in biological studies.

Autumn-sown barley

All the varieties dealt with here up to the present are spring sorts, although in certain circumstances some of them are used for autumn sowing with satisfactory results. With the large cereal acreage now demanded in Britain it facilitates farming operations to sow as large a proportion of this acreage as possible in the autumn, in addition to which autumn-sown barley usually ripens somewhat earlier than spring-sown and thereby spreads out or ' staggers ' the period of harvesting. The adoption of autumn sowing as a safe and general practice necessitates a degree of winter hardiness in which most spring sorts are deficient. By crossing Spratt-Archer with a true winter-hardy form obtained from the breeder Tschermack, a winter-hardy two-row barley now known as Pioneer was obtained. The new form, in addition to winter hardiness, possesses high grain-yielding capacity combined with malting quality approximating to that of Spratt-Archer, and thus greatly extends the general agricultural utility of the barley crop.

Feeding barley

There are some soils in England such as those found in the Fens, because of their high content of organic matter, are capable of producing high yields of grain which, unfortunately, is almost invariably inferior in quality. The problem in such cases appears to be to admit the position in regard to malting quality, and to endeavour by liberal manuring and by appropriate systems of husbandry to take full advantage of the high grain-yielding potentiality so abundantly offered. This involves straw of high resistance to ' lodging,' and to meet this requirement a variety named Camton was produced by crossing Spratt and Archer-Goldthorpe, both of which varieties as already noted are characterised by straw with high resistance to ' lodging.' Camton has probably the most ' lodging '-resistant straw of any British variety now in cultivation, and can consequently be grown on the most fertile soils, or on less fertile soils with heavy applications of fertilisers, with a minimum danger of ' lodging.'

Early ripening barley

Reference has been made previously to the advantages of early ripening in barley in so far as it facilitates farming operations during harvesting by extending that period in one direction, and thereby enhancing the potentiality of the combine harvester.

Earl, a selection from Spratt-Archer, to which variety it is closely similar in all respects except that it is seven to ten days earlier in ripening, was introduced in 1947 to meet the requirements just mentioned. The advantage of earliness in the new variety has contributed to its use in northern districts, and in areas of heavy rainfall and consequently lower summer temperatures, where Spratt-Archer cannot be grown successfully. While the advantages of its use under such conditions are readily appreciated it is interesting to note that Earl has also found a place in the east of England which is regarded as an early ripening area. Here the reason for its success is less obvious but appears to be related to the association of earliness and more rapid establishment of the plant in the early weeks of development. In the east of England early summer droughts are not unusual, and under such conditions the early establishment of a crop, in so far as it is concomitant with a quickly elaborated root system, provides better means of resistance to a scarcity of moisture. It is thus significant that grown under comparable conditions Earl produces grain with a higher 1,000-grain weight than Spratt-Archer. To this extent, although it has no claim to being drought-resistant, it may be rightly described as drought-escaping.

Varietal purity

The enhancement in yield due to the introduction of improved varieties of malting barleys in the British Isles during the

Varieties of malting barley: *left,* **Spratt-Archer;** *centre,* **Pioneer;** *right,* **Prefect**

past 50 years is not overstated at 20% or one quarter, which is equivalent to 4 cwt. of grain per acre. This has been brought about concurrently with a significant increase in malting quality and marked improvement in straw characters which, quite apart from enhanced yield and quality, has reduced the cost of production and hence increased the value of the barley crop to the farmer. While the greater part of this benefit may unquestionably be attributed to the production and introduction of improved varieties, a widespread appreciation of varietal purity in seed as a contributory factor must not be overlooked. Varietally pure seed provides the better chance of obtaining maximum yield and quality in any variety and, since individual varieties behave differently on the malt floor, the same condition in the produce enables the maltster to obtain maximum quantity of extract at minimum cost.

Ease of threshing

The betterment of the British barley crop has here been described comprehensively in terms of yield, malting quality and resistance to 'lodging,' but contributions made in an ancillary sense deserve notice. As all these in their individual and particular bearing are equally important, it is almost invidious to pick out any single one as an illustration, but ease in threshing may be mentioned if only as an example of the many changes which have been effected so gradually as to escape notice entirely or, because of lack of contrast, are now accepted without question.

During the period in which Goldthorpe was widely cultivated, a strong criticism of that barley from the agricultural point of view was the difficulty it presented in threshing, due mainly to a brittle rachis associated with the tenacity with which the individual grain, or more often groups of two or three grains, passed through the threshing mill attached to an attendant portion of the rachis. More frequently the basal section of the shattered rachis left on the straw carried a few grains away with it. In this respect Goldthorpe presented a marked contrast to Archer and later to Spratt-Archer, both of which varieties are remarkable for the manner with which they can be threshed without loss or damage to the grain.

A corrective adopted in threshing Goldthorpe was to set the breast of the thresher closer to the revolving drum, but this adjustment, while securing a cleaner sample, frequently entailed cracked or chipped grain, and the farmer was thus faced with the choice of two evils. Plumage-Archer, which superseded Goldthorpe and all other broad-ear forms of malting barley in Britain, was obtained, as already noted, by crossing Plumage, a form of Goldthorpe, and Archer; in the hybrid the difficulty, which at one time was very real and militated seriously against Goldthorpe, has been removed and is now almost entirely forgotten.

Conclusion

Finally, the automatic limitation of the number of varieties in general cultivation has proved an important contribution in the improvement of the crop. With Spratt-Archer and Plumage-Archer this was effected by reason of their superior yield and malting quality combined with sharply defined varietal adaptation to definite environments. In effect the benefits of this varietal differentiation are shared by the farmer and maltster, for the one is assured of a variety of unquestioned suitability to his land and climatic conditions, while the other is enabled to secure supplies of one variety from definite areas, thereby ensuring a large natural measure of uniformity of material, a factor of unquestioned commercial value in malting and brewing as it is in processing other agricultural products.

N. Rhodesia to Produce more Sugar and Rice?

A number of firms have shown interest in the possibilities of large-scale sugar production in Northern Rhodesia. Recently the Minister for Agriculture told the Legislative Council that the Government is doing all it can to assist the establishment of a sugar industry. Later in the debate the Economic Secretary said Northern Rhodesia's sugar consumption had risen from 3,500 tons to 6,000 tons a year.

The export of rice from that country should also be possible if present developments in the swamp areas adjoining Lake Bangweulu follow the plans drawn up by the territory's Department of Agriculture.

The eventual production of 1,000,000 bags of rice in the Bangweulu region has been mentioned as being a possibility.

Mediterranean Fruit Fly Controlled by DDT

It is reported that promising results have been obtained from experiments conducted by the Department of Agriculture, Cyprus, for the control of the Mediterranean fruit fly—*Ceratitis capitata.* This insect, attacking apricots, peaches, figs, mandarins and other fruit, has become a menace; in the last few years growers have cut down hundreds of trees. The experiments have given the following results:—Unsprayed trees, 60 to 90% attacked; unsprayed trees in treated orchard, 30% attacked; trees sprayed with lead arsenate and sugar bait, 30% attacked; trees sprayed with DDT, wettable, 10% attacked; trees dusted with DDT powder, 6% attacked. Three sprayings were done at fortnightly intervals.

The South Pacific Commission

Extensive Crop Developments Being Undertaken

ERIC FORD, B.Sc.(Econ.), B.Comm.

AS a result of an extensive programme of work now being carried out by the South Pacific Commission, important developments may be expected in a widely-scattered area lying generally south of the Equator and east of and including Netherlands New Guinea. At the Canberra Conference of 1947 the Governments of Australia, France, the Netherlands, New Zealand, the United Kingdom and the United States jointly set up the Commission as an advisory and consultative body aimed at advancing the economic and social welfare of the peoples of the non-self-governing territories administered by them in the South Pacific area.

Auxiliary to the Commission is a Research Council to whose specialist members (chosen for their knowledge and experience of the problems of the area) falls the duty of recommending suitable projects to the Commission. They also make the necessary arrangements for carrying out those recommendations which are accepted. Finally, in order to associate the native inhabitants with the plans drawn up for their advancement, a South Pacific Conference on which sit representatives of all the territories, meets periodically to review progress and suggest future courses of action. (The first of these conferences was convened in May of this year.)

Though clearly the Commission must deploy its resources over a wide range of problems, the major share of its activities is at present directed towards agricultural development. Indeed, of the 28 projects currently under way, no fewer than 10 are directly concerned with crop development, while many others in the fields of health and social welfare have an important bearing on future agricultural possibilities.

Coconut cultivation

As a starting point, the Commission selected copra, which has for long been the basic crop throughout the area and accounts for some 75% of the total agricultural exports. Hitherto, little experimental and research work has been done on the coconut palm and its products in the South Pacific region and, similarly, though in a less striking degree, few attempts have been made to increase its productivity through improved cultivation. It was also considered necessary to undertake investigations of market prospects and marketing arrangements for copra.

Much could be done to encourage pineapple cultivation in the South Pacific Islands

From its analysis of this problem, the Commission at its fourth session in Anse Vata, Noumea (New Caledonia), in October of last year, outlined a programme of research and development. In furtherance of this scheme an examination of the laboratory and field research necessary has been instituted, and a specialist member of the Research Council is now visiting the various production centres in the area. He is bearing in mind not only promising fields for long-term research but also any practical steps likely to lead to improved productivity in the short run. At the conclusion of this preliminary enquiry, the Commission will consider convening a copra conference at which the principal authorities would discuss how best to proceed with the research and how to introduce improved methods.

Since the marketing problem cannot be considered in isolation from the world copra situation, the Commission has moved rapidly ahead with a survey of world copra prospects. The full-time member of the Research Council responsible for economic development, Dr. Howard G. MacMillan, has already visited the United States, where he had discussions with the United States Departments of Agriculture and Commerce and made contacts with large commercial firms in San Francisco. He continued his discussions in London, where he met representatives of commercial undertakings as well as authorities of the Colonial Office and Imperial Institute.

Summarising the results of his tour on his return at the close of 1949, Dr. MacMillan stated that though there had been a great scarcity of all oils and fats, owing to the stimulated production of certain vegetable oil crops and the return to cultivation of large acreages which were out of production owing to the war, there might be a possible world surplus of fats and oils in the future. Nevertheless, at the moment there was still a shortage variously estimated at up to a million tons annually.

This report underlined what the Commission had already felt to be vitally necessary, namely a more widely diversified range of crops in the South Pacific area; particularly is this so since a preliminary survey indicated that the whole area is characterised by a great paucity of indigenous economic plants. That this can be remedied is shown by the examples of Ceylon, Malaya and Indonesia where the Governments have in the past introduced many valuable new economic plants; for example, only some 20% of the present-day economic flora of Indonesia is indigenous.

Introduction gardens

Accordingly, the Commission is pressing ahead with the institution of ' Introduction Gardens,' where non-indigenous plants can be ' introduced ' and their reactions studied. The gardens will also house a collection of coconut varieties and other crops already under cultivation in the South Pacific.

It is proposed to introduce a wide range of plants, including subsistence crops, fruit trees and economy crops. Nurseries are to be started for the distribution of seedlings and grafted plants, and a particular need is for plants suitable for isolated atolls.

Much has already been done towards implementing this programme. Introduction gardens have been instituted at Naderolulu in Fiji (British territory) and

at Port Laguerre in New Caledonia (French). At the latter the local Departments of Agriculture and Forestry, and the Veterinary Service, are co-operating with the Commission in developing a tract of land of some 1,300 acres in extent, to which is also attached a farm school. The Commission assists with technical advice and finance. Similar gardens are projected in Netherlands New Guinea and Australia.

Help has also arrived from other sources. A local tribe, known as the 'Col de la Pirogue,' has gathered 1,000 kg. of seeds of *Leucaena glauca*, which is to form the basis of the first attempt at re-afforestation in New Caledonia. From the Forestry Experimental Station at Buitenzorg in Java have come various economically valuable seeds, including several pounds of *Pinus merkusii*, the fire-resistant Sumatra pine.

Pasture and animal improvements

Another project deals with tropical pasture and animal improvement and also has regard to the general problem of unbalance in the Pacific agricultural scene. Work in hand under this head in Fiji includes the selection and propagation of grasses and legumes for animal fodder and on the biological and direct control of weeds in pasture. The Commission plans to extend work of this nature to French New Caledonia and elsewhere as funds permit.

Mr. Granger, Director of Veterinary Service in New Guinea, has suggested that a model farm would be of great help in this connection, though here the main limiting factor is the availability of suitable personnel. In developing this plan, which has aroused considerable interest in New Zealand Government circles, the Commission is considering the appointment of specialists, available as the result of political changes in the south-east Asiatic areas. Through the New Caledonian Veterinary Service it is proposed to introduce pedigree stock, pasture grasses and some dairy equipment.

Land use technique

Related to the general task of expanding crop production is the special problem of land-use techniques, which is all the more urgent because of the unusually thin top soils which characterise the region. The problem has been aggravated by faulty native methods of culture in the past. The Commission felt that it could usefully institute a pilot land-use survey on a selected island, where experiments could be undertaken using known and tried techniques with the aim ultimately of preparing a land-use map for the whole South Pacific area. Particular problems include methods of erosion control, the delimitation of marginal land, the setting up of hydrological and forestry reserves and re-afforestation projects.

Native boy climbing for green coconuts near the Sepik River in New Guinea

Since this overall plan was prepared the Governor of French New Caledonia has agreed to the location of the pilot project at a point north of Bourail, and a team consisting of a forester, a soil scientist and a surveyor is now commencing work, basing their efforts on a report specially prepared by the Commission on up-to-date methods of land utilisation and conservation in other tropical areas.

The coral islands

Other projects in the Commission's programme relate to the numerous coral islands which suffer from a scarcity of economic plants. Even the coconut palm has been less successfully developed there than elsewhere and a programme of coconut palm development has been adopted.

Equally urgent is the need for alternative crops; examples include bread-fruit, taro, banana, sweet potato, vegetables and citrus fruits. Preliminary research is essential, and a small agricultural station in Abemama is already in hand under the aegis of the administration of the Gilbert and Ellice Islands Colony. Outside help is to be solicited and contact has been established with Dr. Harold J. Collidge and Dr. Fosberg of the Pacific Science Board of the United States National Research Council, which is undertaking a preliminary survey of a typical coral atoll.

Assistance has also been forthcoming from the Deputy Director of Agriculture in Fiji, the head of the Treub laboratory at Buitenzorg and the Department of Geology of the University of Indonesia.

Field work is also in train on a small coral island near Noumea and a soil specialist with tropical experience is at work in a small laboratory on the site.

Nutrition studies

The Commission realises that for some time to come a large share of its attention must be directed to subsistence economies. Throughout the whole area there is an urgent need to raise living standards, and one project (Subsistence of Indigenous Peoples) is devoted specifically to this problem. As yet research into the dietary standards of indigenous peoples is only in its rudimentary stages, and member Governments are being urged to undertake nutritional studies. For their guidance they have been offered sets of reports on dietary studies carried out in Indonesia during the past 20 years.

In addition to the general theme, research is also in hand on various methods of preserving perishable locally produced foodstuffs.

Rural credit

Obviously it will be impossible to implement long-term plans for raising the standard of native production without the provision of credit facilities. Before embarking on any large-scale plans for credit provision, however, the Commission has requested member Governments to provide information on the existing monetary systems and credit facilities in their non-self-governing territories. The Australian Government is now undertaking a systematic study of this particular problem in its own territories, and has undertaken to keep the Commission advised of progress made in this connection.

Collaboration with other organisations

The Commission has already been in touch with several interested outside bodies, and is closely watching the programmes of technical assistance which are being worked out under the auspices of the Economic and Social Council of the United Nations. The Secretary-General of the Commission, Mr. W. D. Forsyth, has drawn up draft proposals for technical assistance in the South Pacific, which, after approval by the participating Governments, was presented to a Technical Assistance Authority. They were considered

by the Research Council at its second session in Sydney in August of this year.

Contacts are to be established with other United Nations specialised agencies, *e.g.* the Caribbean Commission, the Economic Commission for Asia and the Far East and Indo-Pacific Fisheries Council—all of which in varying degree face problems similar to those of the South Pacific Commission. Particularly close relations are to be forged with the Food and Agricultural Organisation of the United Nations. The first important task is collaboration in the World Agricultural Census now being undertaken by FAO. This ambitious scheme, to which the Commission, equally with all other members of the FAO, are committed, involves a detailed examination of agricultural resources, including acreage under cultivation, crops grown, livestock population, etc. The collection and collation of this information, which is of vital importance to future world food plans, is a particularly heavy task for Governments responsible for underdeveloped territories, and to obtain even minimum results in the South Pacific the Governments concerned will have to pool all available information; as a first step the Commission is experimenting with suitable sampling techniques. To date, the Governments of Papua-New Guinea, Fiji, and the New Zealand Island Territories have submitted information as to the methods they propose to adopt.

Conclusion

Clearly these far-reaching agricultural proposals cannot be disassociated from the Commission's work in other fields. There are five major projects in the field of health, including the collection of information on epidemiology, infant and maternal welfare, diet and nutrition, as well as on the incidence of tuberculosis, filariasis and elephantiasis.

Under the heading of social development the Commission is engaged on ten projects, which include vocational training, educational advance (particularly the use of visual aids and the elimination of mass illiteracy), the introduction of co-operative methods, and projects for community development along the lines of the now-familiar United Nations' pilot project in fundamental education in Haiti.

Undoubtedly the work of the South Pacific Commission will be watched with keen interest by people and authorities all over the world. Its purpose is to raise the level of production of both cash crops and subsistence economies in a backward area, to the lasting benefit, not only of the indigenous inhabitants but also in the interests of the world at large.

[*Photos: pp.* 413 *and* 414, *Imperial Institute, London*

Native labourer cutting copra in a coconut plantation, Papua, New Guinea

Notes from South Africa

Sugar mill for Natal

An inland sugar belt for Natal, producing an annual crop of nearly £1,000,000 with a £1,000,000 mill situated at Pietermaritzburg to handle the crushing is at present under discussion. So good has been the progress of experimental cane planting in the lower Natal Midlands that the few farmers who have established sugar as a regular crop consider that it has now come to stay, and that a central mill for the area will have to be built. At present, most of the sugar-cane farms are on the coast belt and all the mills are there. But in recent years, experiments in the Richmond-Thornville area, near Pietermaritzburg, have proved that, in spite of the cold of the higher altitudes, cane thrives there. While there are now only about 1,000 acres being cultivated, it is estimated that there are another 30,000 acres of land around Pietermaritzburg which could profitably be put under cane if a central mill were available. Without a mill this development would probably be unprofitable or just 'break square' because of the rail tariffs. It is costing farmers 7s. a ton to get cane to the coast mills for crushing.

1950 vine sale at Paarl

Except in the case of a few white wine varieties, there was a rise in the price level at the 1950 sale of vines in Paarl, after an annual decline of 10% since the 1947 peak. The outstanding feature of the sale was the generally high level at which rooted and unrooted cuttings sold. Cuttings generally, of which the supply of almost 1,000,000 was larger than last year's offering, were up on last year, although still short of the record level of 1947 and 1948. The sustained demand for cuttings at exceptional prices is probably due in part to a fear of war. Planting cuttings gives the farmer another year's chance to decide whether he will graft wine or export table varieties on them.

Cotton hybridisation

Dr. W. L. Fielding, principal of the College of Agriculture at Gwebi, Southern Rhodesia, described to the congress of the South African Association for the Advancement of Science at Salisbury cotton hybridisation experiments at Barberton, which resulted in an increase in lint yield from 100 lb. per acre to 700 lb. per acre in 24 years. The local effect of the Barberton breeding work was to keep South African cotton production going through a very difficult period.

Insect pests, said Dr. Fielding, were the major factor interfering with cotton growing in the early years, but with the recently evolved jassid-resistant vigorous-fruiting strains of cotton evolved at Barberton, these infestations were unlikely to prove totally destructive in the future. In the Rhodesias, Nyasaland and Portuguese East Africa, strains of the U.4 family bred at Barberton soon contributed to cotton production. In Uganda, Tanganyika and the Belgian Congo they provided useful breeding material. The U.4 was the name given in 1924 to a single plant in a plot of cotton grown from seed, which was believed to have originated in Uganda. Selected by Mr. F. R. Parnell, this plant resulted in a family of jassid-resistant cotton in which intensive selection was practised at Barberton until 1939.

The World Problem of Erosion

Farm Face-Lifting

In an editorial comment in our issue of November 1949, we had occasion to refer to the one-day demonstrations which have attained considerable popularity in the U.S.A. as a feature of the national campaign for the conservation of the soil. Interest has been evoked in this matter in various other parts of the world, and to meet the demand for further information we print below an account of the movement, which has been supplied to us by the United States Department of Agriculture, together with a summarised report of the organisation and results of one particular demonstration lately held in Maryland. For these operations the Americans have devised the characteristic and picturesque designation of 'farm face-lifting,' and from the details given it becomes possible to gain a clear idea of the manner in which they are organised and the benefits and results which may accrue therefrom.

A FARM 'face-lifting,' in its present conception, consists of installing a complete soil conservation programme on a farm in one day, insofar as is seasonably possible. Aside from the benefits to the farm selected for the demonstration, a face-lifting serves two principal purposes. First, it dramatises the need for soil and water conservation. Second, it demonstrates to many people at one time that successful soil conservation means not just the use of one or two practices, but a well-co-ordinated programme that combines all needed practices in a complete conservation farm plan.

(Top of this page)
About 45,000 spectators came to this face-lifting on a Maryland, U.S.A., farm

The beginning

The earliest demonstration of the kind was held on November 7, 1941, on the farm of Harry W. Shealey, 8 miles from Newberry, in Newberry County, South Carolina. A week later, on November 14, a similar demonstration was held on the farm of Ira B. Newsom, 4 miles west of Bishopville, in Lee County, South Carolina. The idea seems to have originated with Ernest Carnes and J. H. Johnston, technicians employed by the U.S. Soil Conservation Service, and located in South Carolina. Each of the two farms covered about 135 acres, but otherwise they were quite different. The Shealey farm was selected to represent Piedmont conditions, and the Newsom farm to represent coastal conditions. C.C.C. enrollees from nearby camps did most of the work during the one-day demonstrations. Equipment was furnished by the camps and local farmers. Neither the Shealey farm nor the Newsom farm was mechanised at that time. About 1,500 people attended the demonstration on the Newsom farm.

Although the term 'farm face-lifting' had not then been thought of, these two early demonstrations were similar to the ones being held today, with complete conservation programmes established in a single day. The farm plans were made by technicians of the Soil Conservation Service, who with the aid of large farm maps and loudspeakers briefed the crowd on what it was all about. Practices applied

included terraces, meadow outlets, contour strip cropping, pasture and woodland improvement, liming, fertilising, pasture seeding, planting field borders, construction of contour fences and others. Extension specialists and foresters joined the Soil Conservation Service technicians in discussing the work at different points as groups of visitors were conducted over the farm.

Post-war developments

Because of war, there were no more such demonstrations until September 21, 1946. On that day the first major face-lifting demonstration was held on the farm of Claude Milner, near Pleasantville, Iowa. Originator of this event was Clay Barnett, district conservationist for the U.S. Soil Conservation Service at Des Moines.

For several years previously, radio station WHO at Des Moines had served as one of the principal sponsors of a corn-belt ploughing match. Barnett had been active in this programme. A group of committee men, including Barnett, met in the spring of 1946 at a hotel in Des Moines to plan for the 1946 ploughing match. It was at this meeting that Barnett brought out his idea for a farm face-lifting, which would accomplish in one day as much soil conservation work as the average farmer could do in four or five years. The committee agreed, and all went to work with enthusiasm to organise and plan a great conservation demonstration for early autumn.

The success of this first major face-lifting was an eye-opener for everyone. It drew an attendance in excess of 40,000. Co-sponsors with WHO were the Marion County Soil Conservation District, the Soil Conservation Service, the Iowa Department of Agriculture, the Iowa State College and Extension Service, the Farm Bureau and Chambers of Commerce of the towns of Knoxville, Pella and Pleasantville. A total of 250 farmers and Iowa business men donated a day's work, while implement companies and commercial firms supplied equipment and materials, and Claude Milner himself put up $3,000 for purchase of such cash materials as fencing and other items.

The principal address of the day was delivered by Dr. Hugh H. Bennett, chief of the U.S. Soil Conservation Service, and was broadcast over a national network. The press gave the event wide publicity. It was, in fact, the newspapers who dubbed the demonstration a 'farm face-lifting.' The appellation took hold immediately and has been generally used since to refer to this kind of demonstration involving the remodelling of a farm on a conservation basis in the working hours of one day.

Spread of the idea

After this first major farm face-lifting, the idea spread rapidly. Some 20 such events were held in 1947 in six different states, including Iowa, Minnesota, Illinois, Wisconsin, Ohio and Kentucky. During 1948 more than 70 such demonstrations were held in many different states, making a total of about 100 altogether in the two post-war years. In 1949 there were more than 100 such events. The face-liftings have drawn an attendance of upwards of 2,000,000 people, many of whom came from cities to take their first object lesson in soil conservation. Likewise, most of the larger and some of the smaller face-liftings have been visited by people from foreign countries. Many members of foreign embassy staffs, as well as personnel of the United Nations' Food and Agriculture Organisation, have attended face-liftings for the specific purpose of helping to spread and speed up soil conservation in other parts of the world.

Face-liftings were held in the spring and summer of 1949 in the Dakotas, Nebraska, Kansas, Arkansas, Tennessee, and other parts of the U.S.A. Usually it takes several months to plan and organise a face-lifting.

The objects

A conservation face-lifting is definitely the people's own show. The primary purpose is to speed soil conservation in the community. Someone in the community gets the idea, passes it on to others; the next step is to secure sponsorship by a group, or groups, able to promote the project and raise the necessary funds. Some of the organisations which have effectively co-operated in sponsoring face-liftings in the past two years are: Soil conservation districts, the Farm Bureau, newspapers and radio stations, farm magazines, bankers' associations, chambers of commerce, junior chambers of commerce, Friends of the Land, colleges, the American Legion, machinery dealers' associations, church organisations, state associations of soil conservation districts, Extension Services, all major civic clubs, veterans' training classes, the Red Cross in providing first-aid units, and such youth groups as the Future Farmers, 4-H clubs and Boy Scouts. Business concerns in all categories have contributed to most of the face-liftings so far held throughout the U.S.A.

Mode of organisation

The sponsors usually appoint a general manager, with assistant directors, whose duty it is to form an administrative body sufficient to attend to all details. The general manager is usually a well-known public figure, active in farm circles, and alert to all phases of the life of his community. He may be a farmer or rancher, a farm editor, a member of the local soil conservation districts board of supervisors, or if the event is on a state-wide basis, a member of the state association of soil conservation districts.

Selection of committee membership comes next. A sample committee might be headed by a general advisory committee, with eight to ten major committees listed under it, and enough sub-committees to attend to the many and varied details involved. Major committees include those on publicity, on farm operations, on parking and traffic, on machinery and equipment, on concessions, and a programme committee. Under the general farm operations committee would be included appropriate sub-committees on trucking and spreading lime, fence removal and construction, diversion ditch or terrace

Equipment prepares a seed bed during a conservation field day on a farm in Waleska, California

construction, pond construction, fitting seed beds, pasture renovation, tree planting, drainage tile installation, technical exhibits and on other technical subject matter. The magnitude and diversity of the demonstration activities will guide the extent of the administrative set-up. Experiences have shown that the secret of successful face-liftings is in having as many people as possible actively participating long in advance of the actual demonstration day. Time and effort of all participants are donated and this in itself appears to work for success.

Preliminary preparation

It is considered ill-advised to plan a face-lifting demonstration without starting the organisation at least six months in advance. The press and radio committee usually is set up first, as it is able to activate other committees through the stimulation of timely press and radio releases.

Some of the heavy machinery and the crowd to be seen at a face-lifting

Choice of farm

Selecting the farm is an important feature of planning for a successful face-lifting field day. Many people have a hand in the selection—committee members, neighbouring farmers, business people and others. The demonstration, of course, must be located in an area where there is an active soil conservation district programme. The farm can thus be planned by Soil Conservation Service technicians located in the district, and district supervisors and farmers are available to assist in many phases of the event. Any normally populated area will do. If the demonstration is sponsored on a state-wide basis, a central location is desirable. Locating a demonstration within a reasonable distance of a larger centre of population contributes to better co-operation from civic organisations and calls the attention of city people to soil conservation. Good roads leading to the location are essential.

Construction of a two-acre fish pond under supervision of the Soil Conservation Service

Face-liftings have been held on farms of all sizes, from 30 acres to 200 acres in the east and middle west, and as large as 800 acres in the west. Usually a large farm is considered best, the size being limited only by the ability of the labour crews to complete the entire job in one day. Experience has shown that the size of the operation is a strong drawing card in attracting spectators.

The committees select a farm that is fairly representative for the area in which it is located. It is preferable that somewhere near half of the land be under cultivation, that part of it is rolling and part level, and that there are evidences of erosion recognisable to the layman's eye. However, it should be in such condition that a change-over to soil conservation will make the land capable of raising and educating a farm family in line with better community standards of living. The farmer himself should be enthusiastic about the soil conservation way of farming and willing to continue the programme as a permanent way of using his land.

Source of funds

A face-lifting event should be, of course, a non-profit undertaking. Usually no admission, entrance, parking or other charges are permitted except for food and soft drinks. Cash required for the demonstration is usually donated; seed, fertilisers and lime, fencing and building materials, planting stock, facilities, and labour and equipment are donated. For a major face-lifting, as many as several hundred individuals or groups may contribute in one or more ways. The owner of the farm is frequently the largest contributor himself, in that he supplies seed, fertilisers, equipment and cash if he can afford it.

Official help

Agencies of the Department of Agriculture contribute exactly what they contribute in helping any farmer do a better job on his land—technical counsel. Representatives of the Soil Conservation Service make the conservation farm plans for the face-liftings. Uusually they supervise the work of installation on the day of the demonstration. Extension Service representatives also participate; county agents usually serve on one or more of the committees, and Extension information specialists assist with the information programme preceding the demonstration.

Results and benefits

The benefits of a face-lifting field day now are widely apparent. Such demonstrations keep the subject of soil and water conservation in the public mind weeks before and after the event. They are effective in showing to many farmers at one time what is meant by application of a complete farm conservation plan. They help the city man and farmer to realise they have a mutual interest in the soil.

They demonstrate that soil conservation now is a generally accepted thing among good farmers. They stimulate farmer interest in the soil conservation districts. They present the complete picture of soil conservation to farmers who are in the early stages of applying conservation plans and help them speed up their programmes.

A report on the farm of Claude Milner, near Pleasantville, Iowa, where the first major face-lifting was held on September 21, 1946, will give an idea of the benefits to the farm selected for the demonstration. In August 1948, Mr. Milner said, 'I can truthfully say the production on the farm as a whole has more than doubled' in the two years since the demonstration on his farm. His corn yield increased from 33 bushels an acre to an average of 60 bushels in 1947. The production from his permanent pasture more than doubled. In addition, the face-lifting on the Milner farm has been instrumental in influencing other farmers, both in the immediate neighbourhood and over the country, to adopt soil conservation programmes.

An actual demonstration

The following is a summarised description of an actual demonstration which was held on a farm in Maryland in August 1948, together with a short account of the manner in which it took its rise and the main points in its organisation. It has been prepared from the official account of the demonstration.

What took place

The demonstration was held on the farm of Mrs. Nellie Thrasher in Frederick County, Maryland, and was attended by some 40,000 people. It started at 8.45 a.m. when the crowd heard, over a public address system, an explanation of this community effort to dramatise modern farming methods. As soon as this was completed the proceedings started with explosion of dynamite charges to open a new drainage ditch, 172 pieces of farm machinery and heavy equipment moved into action, and 500 volunteer workers, operating under the direction of 30 technicians of the Soil Conservation Service, commenced their attempt to accomplish in one day what would normally have taken several years to complete.

Their activities were co-ordinated by a 'walkie-talkie' network and a map on the bandstand recorded hourly bulletins of the progress of their contest with time.

To accommodate the large attendance all necessary facilities were provided and bands and musical entertainments enlivened the intervals between addresses and progress reports.

In the course of the operations a new road was cut and graded through the farm. Old fences and the rocks bordering them were removed and replaced by thousands of feet of new fence constructed along the contour. Gullies were sloped and seeded; thousands of feet of terraces were built. Thirteen acres of arable land were limed and fertilised; 52 acres were prepared and sown to pasture and 22 acres were strip planted. In the course of these operations 92 tons of lime, 24½ tons of fertiliser and 1,300 lb. of seed were used.

A sky pond was excavated and constructed to form a permanent water supply, the excavated earth being used to fill the low-lying barn lot which was formerly often flooded. A new prefabricated barn for 22 cows was erected on a previously laid foundation and new equipment installed in it. A new silo, previously erected, was mechanically filled with fresh machine-cut fodder. A portable saw mill and a mechanical tree planter were put to work on a demonstration of wood-lot management.

The farmhouse was repaired and insulated and its exterior repainted, while the yard was landscaped and shade trees trimmed and treated.

By 5 p.m. the work was practically complete and a new kind of farm life had been inaugurated.

The event was widely publicised by radio and in the press, while complete records of the day were made on films.

How the undertaking started

The original suggestion to hold a demonstration came from a farmer who had seen a 'Conservation Day' demonstration in Iowa and his description so fired the imagination of his neighbours that a meeting was called which decided to hold a similar demonstration in Frederick County. A board of directors was formed and executive, farm selection and publicity committees appointed. It was decided that the demonstration should include all the standard conservation practices required by a programme to be prepared by the U.S. Soil Conservation Service, and that they should be applied in a one-day demonstration.

The organisation adopted

The main features of the organisation comprised: (1) a sponsoring organisation; (2) a general chairman, a secretary, a treasurer and a general manager; (3) a board of 13 directors and an executive committee of five members, together with an advisory committee of official members to provide official sponsorship and special committees to deal with farm selection, finance and publicity, with a number of others to handle sectional details. The general manager and secretary were paid staff, all others contributing their services voluntarily.

Choice of farm

The farm selected for the demonstration was chosen some 3½ months before it was scheduled to take place. In making a choice the following considerations applied:

(*a*) That the farm should be representative of the area, readily accessible to roads capable of carrying heavy

Terracing wheat land at a face-lifting near Denver, Colorado

Contour terraces in the corner of a field planted to a permanent pasture mixture of love grass and sericea overseeded with Kentucky 31 fescue

traffic and its topography should afford visual advantages for viewing demonstrations.

(*b*) That the owner should be willing to co-operate fully and would guarantee that conservation practices would be continued and maintained after the demonstration.

(*c*) That neighbouring farmers would be willing to co-operate in providing facilities and in particular provide adequate space for parking, etc.

(*d*) That the crops grown and the types of land available would be suitable for operations at the time chosen for the demonstration.

Some points of interest

Written agreements were made with the owner of the selected farm and adjoining properties specifying exactly what was required of all parties. Experience of previous demonstrations at other places showed that this was essential.

To provide a basis for a comparative evaluation of the selected farm before and after the application of the conservation measures an appraisal was made by a board of land valuers and its value fixed at $13,625.

Ground maps and aerial survey photographs of the farm were provided in advance in order to facilitate preparing detailed plans for the demonstration.

The overall plan for the demonstration comprised two separate aspects termed: (*a*) The conservation plan, which embraced all operations in the field; and (*b*) the modernisation plan, which embraced all operations affecting buildings, roads and the amenities surrounding.

Much of the equipment used was loaned and a large part of the materials donated. Funds were raised by contribution from organisations and public bodies; subscriptions were not sought from private individuals. No charge was made for admission to the demonstration and, apart from individual requirements for food and the like, no charge was made for the use of facilities provided on the ground. The actual sum expended on the demonstration, apart from goods and services loaned or donated, amounted to $17,179.

Results of the demonstration

In their report, written immediately after the demonstration, the organisers recorded that experience showed that the organisation was somewhat over-elaborate and better working would probably have been achieved with fewer committees of smaller size.

They concluded that the value of the day as a means of directing public attention to the need for conservation of our soil, water and woods was substantial, but, since the farm will be regarded as a demonstration farm for years to come, to what extent the field day will materially advance the cause of conservation in Maryland will be determined by what happens on the acreage next year and for some years thereafter.

The rebirth of the farm was deliberately dramatised and not intended as a practical or economical way to convert a farm. The elements of a stunt were present, and had to be in order to make over a 175-acre farm in a single day. Obviously the cost of the one-day spectacle far exceeded what would be the usual cost of applying the same practices. Everything that was done helped this farm, but a good deal should be classed as part of the show rather than as conservation.

Since then reports have come to hand of the position twelve months later, *i.e.* in August 1949, from which it appears that the work has been productive of substantial benefit. The conservation programme initiated is reported to be well maintained and greatly improved yields of farm crops and milk have been recorded. Wheat yields have risen from a previous level of 18 bushels to 24 bushels per acre and for barley from 16 to 20 bushels, while the pasture land has improved out of all knowledge.

A revaluation of the farm carried out in August 1949 placed its value at $26,400, as compared with $13,625 before the operations were undertaken.

From a publicity point of view the farm seems to have attracted much attention and it is recorded that many thousands have visited it since the demonstration took place.

It would appear accordingly that the demonstration is beginning to yield substantial fruit.

[*Photos: Soil Conservation Service of the U.S. Dept. of Agriculture*

Royal Society of Arts Prize

The Royal Society of Arts have recently announced that as part of the celebrations of the centenary of the Great Exhibition of 1851, which it originated, the Council propose to award a prize of a gold medal and a sum of £500 for a new and outstanding contribution to the national economic recovery. In so doing they will be reviving the practice of offering prizes for inventions and other objects which was employed by the Society in its early years. The prize is to be offered for a means of promoting the production or the economic utilisation of food in Britain.

Proposals submitted may be quite general or may be concerned with any branch or aspect of food production. Examples of the kind of proposal which the Council are seeking are: An overall plan; a scheme for encouraging return to the land; a system to ensure the marketing of perishable food in better condition. They must be well documented and the Council have therefore decided not to prescribe any fixed limit of length for written communications. The judges may require some practical demonstration of any mechanical device or process submitted.

Entries, which may be submitted by British subjects, citizens of the Commonwealth and the Irish Republic and foreigners permanently resident in the United Kingdom, must reach the Secretary of the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, by March 1, 1951.

Mechanised Rice Production in British Guiana

The Mahaicony/Abary Rice Development Scheme

With a world shortage of rice increasing attention is being turned in many parts of the world to the use of mechanical methods of planting and harvesting the crop with a view to lessening the hard and laborious work of the traditional methods of cultivation. In British Guiana large scale trials with mechanised rice growing have been in progress for some years; the following account, based upon a recent report, gives details of the results so far achieved.

THE Mahaicony/Abary Rice Development Scheme originated in 1942 with the object of developing an area of about 11,000 acres, lying between the Mahaicony and Abary Rivers, for mechanised rice cultivation. The British Guiana Rice Marketing Board, which handles the entire crop of the Colony, has operated the Scheme through an *ad hoc* Board of Control. The aim has been to cultivate 5,000 acres as a single Government-operated unit, and also to make available for hire to individuals in the neighbouring area machinery suitable for mechanised rice cultivation. Since the inauguration of the scheme many types of machines have been introduced and tried out until ultimately a satisfactory system of cultivation and harvesting has been devised. The hire system has been operated successfully, although at unremunerative rates, while the quantity and quality of the rice produced has been a valuable contribution to the resources of the country and to the requirements of the West Indies.

It has also been decided to erect at least one modern mill as an example of what might be done to replace the large number of small mills scattered throughout the Colony.

A recently-published Report* describes the many difficulties encountered in this pioneer scheme, how they were overcome, and includes valuable data on the cost of working all operations.

The mechanised production of paddy is not new, for it operates successfully in the United States and elsewhere. Methods used in the United States, however, are not directly applicable to tropical conditions such as exist in British Guiana, so that while every advantage was taken of experience in the United States, a number of innovations were necessary to suit the system to the particular conditions in the area covered by the Scheme.

Angle dozer levelling land for rice cultivation

Irrigation and drainage

The successful cultivation of rice depends on the plentiful supply of irrigation water and on good drainage. The latter is perhaps of greater importance than the former, especially where the crop is grown and harvested with the aid of machinery. In British Guiana the mid-year rains may be depended upon, but the end of the year rains are uncertain, necessitating irrigation and efficient drainage for the crop planted in the autumn for spring reaping. Drainage calls for perfect control of the water throughout the growing period, and this cannot be obtained without an exact knowledge of the contours over the whole area. This preliminary survey appears to have been omitted in the present instance, with the result that the construction of many drainage waterways was hurriedly effected on a trial and error basis, with consequent loss of efficiency. Most of the major defects have, however, now been rectified and it has been possible to devise a system of drainage and irrigation to suit mechanised cultivation and harvesting.

The size and shape of a paddy field is dependent on the contour of the land. Mechanisation demands large fields; it was concluded that fields of 50 acres would be large enough to work economically and not too large for drainage purposes. This preconceived idea was subsequently modified, as indeed it was bound to be, for the later-developed fields varied in size and shape in accordance with the contour, resulting in better water control and greater economy in working.

Soil

The soil is described as frontland clay, granular in structure and containing about 6 to 7% of well-humified organic matter. Below this is a uniform silty clay extending to a considerable depth. The frontland clay soil has developed on marine-deposited alluvium which is non-calcareous quartzose and kaolinic in nature, and saturated with sea salts. The surface soil is acid (pH 5.31), the pH increasing to 7.88 at a depth of 36 in. in the profile. The indications are that the soil has been subject

*Report on the Mahaicony/Abary Rice Development Scheme, *The Daily Chronicle*, Ltd., Georgetown, British Guiana, 1950.

to intense leaching. The amount of silt varies from 22 to 29%, and the clay from about 56 to 66%.

Method of cultivation

The relative merits of one or two annual crops are discussed, the first sown in spring and reaped in the autumn, the second planted in the autumn and reaped in the spring. There is much to be said in favour of growing a spring crop on half of the available land, states the report, and an autumn crop on the other half. This, it is said, would fit in well with cattle raising, would increase the chances of eliminating drop-seed and would enable harvesting machinery to be more fully employed. On the other hand, lower yields are secured in the spring crops than from the crop planted in the spring for autumn harvesting, and the spring harvesting must often be carried out in heavy rain. Judged by the results of preliminary investigations it appears possible that the ultimate solution of the problem will be the planting of the crop in spring and the grazing of the land from autumn to spring. The alternative appears to be the production of a ratoon rice crop from the autumn-harvested crop, but this is considered risky as the mechanised harvesting would probably coincide with the rainy season.

No precise information is given on the amount and nature of the cultivation of the land. Mouldboard ploughs were discarded as they were unable to turn in stubble and loose straw; disc ploughs, however, proved successful in this respect. It was found that straw and stubble ploughed in has an adverse effect upon the drying out of the fields, so that the practice of ploughing in stubble and straw has been discontinued. Eventually, a system of under-water cultivation was adopted, as it was found that tractors and harrows could travel through flooded fields and effectively destroy vegetation. This conforms with experience elsewhere in the tropics, where it was found that cultivation of the dry land, unless inundated immediately after ploughing, resulted in subsequent heavy weed growth. The principal benefit of under-water cultivation, states the report, is the almost complete suppression of weeds and of red rice, with consequent improvement in yield. Furthermore, the land so treated appears to dry out more rapidly at harvest time, and—most important of all—the system enables the carrying out of a pre-arranged programme regardless of the weather.

Seeding is carried out by drill or broadcasting, and a 6-in. pipe attached behind the harrows in the final operation creates a level seed-bed.

Tractors working on submerged land preparatory to sowing paddy

Varieties

Many of the difficulties encountered in this project are ascribed to the unsuitability of the present local varieties to mechanised conditions. The production of new varieties more suited for this purpose is therefore being pursued in the Department of Agriculture. The present varieties are suited to the requirements of a transplanted crop where free tillering is desirable, but where the crop is drilled or broadcast and harvested by machinery, tillering has proved to be a distinct disadvantage. Tillering is held to cause uneven ripening, reaping is thereby delayed, and there is a greater tendency for the crop to lodge, thereby increasing the difficulty of using harvesting machinery.

In the United States, harvesting takes place as soon as the moisture content of the grain is reduced to 26%, and green grains do not delay the operation so long as they are in the ' hard dough ' stage. It is considered that the crop should not be allowed to stand for more than three weeks after maturity, or sun cracking results. This rule is inapplicable to the tropical conditions of Britain Guiana owing to the tillering habit of the varieties grown, for even when the moisture content was as low as 24%, a proportion of the grain was still in the ' milk ' stage of development.

Furthermore, the local variety has the habit of prolonging or shortening its maturation period according to the weather, so that, regardless of the date of sowing, maturation takes place at one time. This is held to be a serious drawback as it renders it impossible to arrange a series of sowings with the object of prolonging the harvesting period. It is uneconomic to use expensive machinery for only 15 to 20 days a year, while delay in harvesting results in a reduction of crop. How serious this reduction may be is shown in the following statement: when harvested at the correct time a yield of 123 bags per machine per day was obtained at an average cost of 15.6 cents. per bag; the daily returns decreased steadily from this point until a month later only 33 bags were obtained at an average cost of 63.3 cents. per bag.

A further objection to the local variety is the length of straw, a feature that not only encourages lodging but increases handling costs, and also results in stoppages in the combine through straw wrapping itself round the bearings and interfering with the efficient working of the threshing and separating equipment. The bulk of straw that has to pass through the combine may be so thickly distributed over the straw rack that paddy tends to ride over with the straw and be lost in the field.

The production of a number of new varieties is therefore desirable, so that the crop may be spread over a longer period and be more suited to mechanised harvesting. The ideal variety should have stiff, stout straw, should not tiller freely, and should not readily shatter. The grain should be long, to facilitate separation of the red rice by mechanical means (red rice usually having smaller grains than the cultivated varieties), and because long-grain rice is preferred in the Colony's markets.

Seeding the field

Where a low rate of seeding is practised the crop looks thin and tillering is encouraged. A standard rate of 70 lb. per acre is now employed; this, it is claimed, results in an even stand and uniform ripening, making it easier to determine the right moment to take the water off the land

before harvesting; while this rate of seeding appears to be the optimum which it is uneconomic to exceed, there is no indication that seeding in excess of this rate has any adverse effect.

Harvesting

The right time to commence draining the fields before harvesting depends largely upon the nature of the soil, the weather, and the efficiency of the drainage system. In the area of the scheme the land will hold moisture, sufficient to finish the crop, for some time after the surface water has been removed, the best results being obtained by cutting off the supply of water as soon as full heading has taken place and to allow the water remaining in the fields to dry up by evaporation and transpiration. Drainage must, if possible, be done gradually, otherwise the stems of the plants are weakened and consequently lodging is encouraged.

Methods of harvesting

Many methods of harvesting have been tried. Reaper binders and threshers proved unsatisfactory; they were inefficient with a crop that tends to lodge, while the handling of the crop was expensive, often inefficient, and usually resulted in much loss of grain on account of shattering. Windrowing was attempted but was unsuccessful because the swather gave trouble and there was apt to be insufficient stubble on which to lay the windrow. Ultimately, the J. I. Case tractor-drawn combine with a 6-ft. cut, and the Massey-Harris self-propelled combines with cutting widths from 14 to 9 ft., mounted on tracks, proved successful. The former has proved most satisfactory in dealing with fallen grain, while the latter do excellent work in a short-standing crop, and are cheaper to operate as they need less labour and consume less fuel.

It has been demonstrated that it is possible to carry out bulk harvesting in flooded fields; in fact, when the fields are too sticky and muddy for even the track-laying machines, the water lubricates the bulk harvesting machine and keeps the tracks so free from mud that no bogging down occurs.

Transport of paddy from field to dumps is effected by the use of rubber-tyred, steel-framed ox-carts, and from the dumps to the warehouse rubber-tyred tractor-drawn trailers are used.

Drying and milling

Before the paddy can be artificially dried it is essential that it should be thoroughly cleaned to enable the grain to travel smoothly through the dryer. Shelled grains must also be eliminated otherwise,

It is claimed that this type of under-water cultivation results in an almost complete suppression of weeds

after parboiling, they become shapeless and gummy and in the dryer will gum up elevators, conveyors and dryers, becoming discoloured in the process. A Scalperator, a Monitor and a Carter Disc Separator were installed ahead of the soaking tanks to effect this cleaning of the paddy. It was then found essential that parboiled paddy for milling should be dried to at least 13% moisture, otherwise the paddy gummed up the hullers and brush. Drying problems were eventually solved by drying down to 18% moisture content in a Robinson dryer, and then passing the paddy on to a Hess dryer for the extraction of the remaining moisture. Former defects in colour, attributable to artificial drying, are no longer present.

Improvements were made in the method of parboiling, the principal characteristic of which is the speeding up of the operation as a result of steeping the paddy in water kept in constant circulation at a temperature of about 160° F., thereby reducing the soaking by about four hours. The circulating water is automatically maintained at the desired temperature by a special type of steam-operated pump. Without this pump, the system is dependent upon hand operation, and is difficult to control. Thereafter, it is steamed for about 10 min. only. By this method there is no fermentation with resultant bad odour, and a greatly improved parboiled rice is marketed. It is of interest to compare the technique of parboiling adopted in British Guiana with that recently recommended by the International Rice Commission at Bangkok. This authority recommends cleaning the paddy by blowing and washing, soaking at 25° to 30° C. for one day, changing the water several times during soaking; steaming in autoclave at 120° C. for 15 min. and drying by a counter-current of hot air. This authority suggests that improvement in the parboiling technique is both desirable and possible by simple modifications of the present methods; in cleaning the paddy the water must be changed several times, the temperature should not be too high but sufficiently high to shorten the soaking time to about 12 hours; heating by live steam for 30 min.—atmospheric pressure appears to produce less colouration of the grain; drying at too high a temperature should be avoided to prevent colouration of the grain. The British Guiana technique therefore, in the main confirms this view.

Costs

A recent report of the British Guiana Rice Marketing Board states that operation expenses have recently declined despite the general advance in costs, due largely to the fact that the costs are spread over a larger turnover and to the introduction of additional mechanical equipment and labour-saving devices. Operational costs have necessarily been high during this period of development, and the maintenance of machinery has been a heavy item of expenditure. It is, however, anticipated that these costs will be reduced in future years as a result of better organisation in the workshop and by the systematic training of operators. Accurate estimates of cost of depreciation and maintenance are now available. So long as a yield of not less than 16 bags of paddy is obtained (a bag of paddy weighing 143 lb.) it can be grown and milled at a reasonable profit. In 1949 the yield from 4,000 acres planted on the area gave an average of 13.4 bags of paddy, the best block giving 19.9 and the worst 8.7 bags, while the average annual yield over the whole area for the past four years was 14.5 bags per acre.

Fifteen Years of Chemurgy

M. K. SCHWITZER, A.M.I.Chem.E.

CHEMURGY is not a science nor is it a branch of chemical technology. It may perhaps be called a movement, if by 'movement' we understand a number of people acting in a common cause. It was born in the U.S.A. in the late 'thirties, when the economic depression hit American farmers, who could see no quick way out of the calamity. Concern was felt not only by the farming population but also by other sectors of American industrial, commercial and public life and it was recognised that a bankrupt farmer cannot buy even on the easiest of terms all the goods which an expanding consumer goods industry was prepared to sell him. When therefore a group of farmers and scientists declared that they had found the solution to this vexed problem in a new 'science' (as it was mistakenly termed) called chemurgy, they were sure of getting public opinion behind them. It only needed publicity to propagate it, and publicity it received, until chemurgy was triumphantly carried into the federal capital itself.

From now onwards, things moved fast. Legislation was passed, public and private funds became available and ever-wider circles became interested in the new movement.

Broadly speaking, the aim was to utilise as much farm produce as possible, and particular emphasis was laid on the industrial utilisation of farm waste and surpluses, since to the American farmer the depression was, above all, due to the excess of unsaleable crops.

There was nothing essentially new in all this. Improvement of agricultural methods and farm crop utilisation were overdue in the U.S.A. Some other countries were in this respect far in advance of America.

Indeed the use of agricultural and forest products for purposes other than food is as old as man's history and up to the end of the last century most of the world's industrial activity, apart from coal and ore mining and working, was based on agricultural products.

The rise of chemurgy

The word 'chemurgy' was given to the world by Dr. William J. Hale, research consultant to the Dow Chemical Co. It is derived from the Greek *chemeia* (chemistry) and *ergon* (work). Together they denote 'working with or for a chemical,' and the most important aspect of chemurgy is the production of chemicals and chemical intermediates.

The process of turning casein into fibre has been simplified by Dr. T. L. McMeekin, Head of the Protein Division of the Eastern Research Laboratory of the U.S. Department of Agriculture. The fibre is made into brush bristles, furniture stuffing and cloth

The chemurgic movement grew rapidly and soon began to strengthen scientific and industrial aspects of farming. In 1938, at the instance of Vice-President Henry Wallace, the Bureau of Agricultural Research and Technology was created, and in the same year the Agricultural Adjustment Act (A.A.A.) was passed and four regional farm industrial laboratories set up.

The development of chemurgy

Synthetic rubber

Subsequent events showed that the imaginative policy of the U.S.A. Government came none too soon. When, after the outbreak of World War 2, the Allies were cut off from their natural source of rubber, chemurgy was given a tremendous opportunity. It emerged from it triumphantly.

It was known that utilisable rubber substitutes could be synthesised from petroleum and ethyl alcohol, and the U.S. War Production Board decided on an annual production of 845,000 tons of synthetic rubber to be derived partly from farm-grown grain alcohol and partly from petroleum. By 1943 one-third of the synthetic rubber produced in the U.S.A. was made from alcohol. Today synthetic rubber is a formidable competitor to natural rubber. With this achievement to its credit, chemurgy has taken deep roots in American soil.

The production of synthetic rubber substitutes in the U.S.A. is probably the major single achievement of chemurgy, but numerous developments have also occurred in other directions.

Chemicals from farm products

One of the most important is the production from farm crops of (organic) chemicals and chemical intermediates.

There are two other main sources of organic chemicals—coal and petroleum—but both are also used for heat and power generation and, in fact, only a small fraction is turned into chemicals.

There is a parallel rival claim on farm crops: the production of food and animal feeding stuffs. The proportion of all farm crops going into industry is not accurately established, but its tonnage is certainly very large; on the other hand, the proportion of crops produced going into chemical industries, compared with those used for food, is far greater than the proportion of total coal and petroleum which does so.

It is not possible to discuss even briefly all the important chemical industries using farm crops as raw materials. The few selected are chosen for various reasons: a high tonnage production, chemically interesting products and an original approach promising new developments.

Oils and fats

Among the greatest successes have been those achieved in the utilisation of vegetable oils. New processes and techniques have been devised and existing techniques improved, notably in regard to solvent extraction, refining, hydrogenation, deodorising, saponification and the chemical breakdown of fats and oils.

The great extension of soya bean oil production in the U.S.A. needs no emphasis; today soya bean oil is solvent-fractionated to give a drying oil which is extensively used to replace linseed oil and tung oil, which are in short supply, other fractions being used for making cooking fats, margarine etc. Incidentally, linseed oil production has also greatly increased in the U.S.A.

Today the chemist is gradually coming to look to oils of vegetable and animal origin as a source of new products much as the petroleum chemist obtains a number of cuts from crude mineral oil which can be utilised to yield large numbers of different products.

A recent interesting development, for example, is the production of sulphonates, nitriles and amines used as detergents, wetting agents, toilet articles, bases for plastics and a hundred other purposes.

Synthetic fibres

Another direction in which developments have occurred is in connection with fibres; artificial synthetic fibres are becoming an increasingly important competitor with natural fibres and at present represent about one-tenth of the world supply. Artificial fibres may be derived either from mineral materials or by chemurgic processes from products of farm and forest. The latter can be subdivided into two categories: (*a*) those having a carbohydrate base and (*b*) those having a protein base. A classic example of the first group is rayon, made from wood pulp, cotton linters and similar materials. Of the second, on the one hand there are those made from material of animal origin such as casein and keratin, and on the other those based upon material of vegetable origin, of which groundnuts, soya beans and maize are the chief.

The manufacture of rayon filament was started in France in 1890, from where it spread rapidly to other countries. Of the three principal processes in commercial use, the viscose process is the most important, and accounts for more than 75% of the filament yarn production. The standard viscose yarn and staple fibre are made almost exclusively from wood pulp. High-tenacity viscose yarn is generally based on a combination of wood pulp and cotton linters.

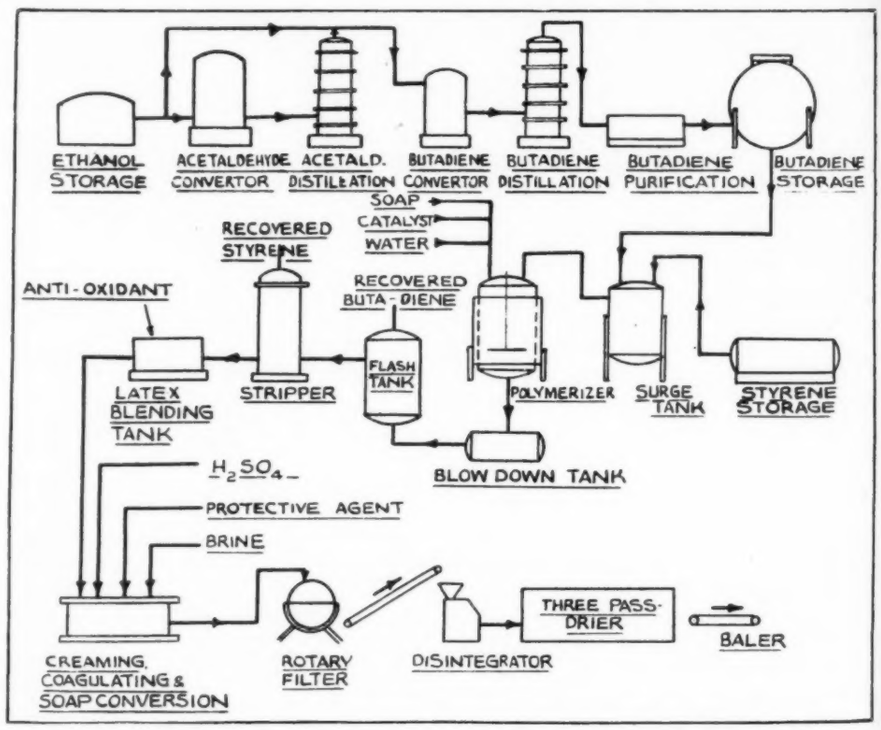
The most important protein fibre is derived from casein. It was first produced on a commercial scale in 1936 in Italy under the name of Lanital. Germany and the U.S.A. started soon afterwards to produce similar materials called Tiolan and Aralac respectively. When casein is dissolved in a solution of caustic soda, sodium caseinate is obtained which is forced through fine jets into a precipitating medium. The filaments thus formed are cut into the required staple lengths and spun into the finished products.

Other animal proteins suitable for making fibres are keratin, found mainly in chicken feathers, and albumen from egg whites, while fish proteins may also be suitable.

Amongst the vegetable protein fibres, those based on soya beans and groundnuts are known best and have been widely publicised. Ardil, a groundnut protein fibre developed in England, may yet become an important material. It is said that a 50% Ardil/50% wool mixture is indistinguishable from pure wool and that it is likely to be cheaper. To make 1 ton of Ardil about 4½ tons of groundnuts are required.

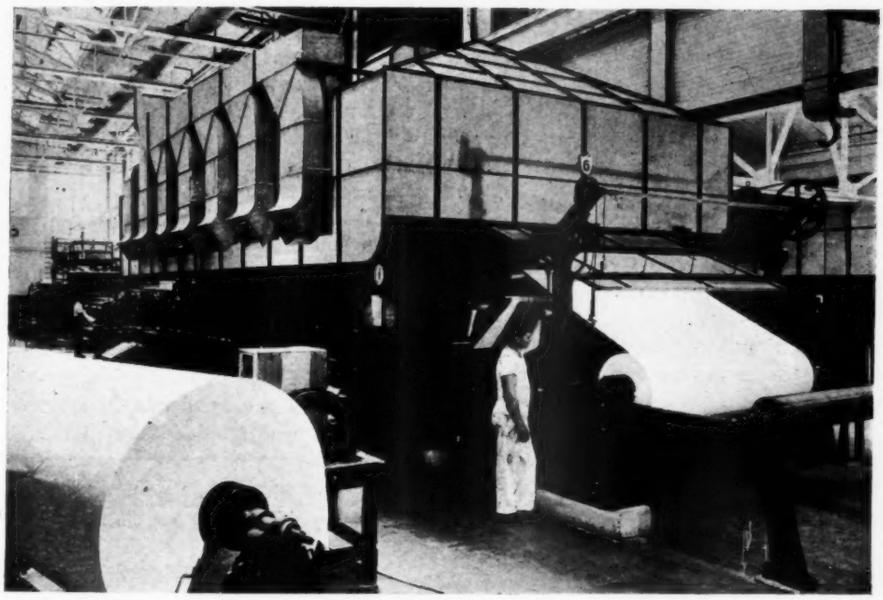
A useful fibre with excellent physical and dyeing properties can be made from Zein, the protein of maize. Until recently results have been limited, but it has been reported by John H. Karr to the 1950 National Farm Chemurgic conference that the Virginia-Carolina Chemical Corporation have, since 1948, manufactured a fibre under the name Vicara. In this process Zein is denatured by treatment with a caustic soda solution and then forced through spinerettes into an acid-precipitating bath. The fibre is then cured, stretched and hardened, dried, textile-processed and cut into staple.

A modern vegetable oil extraction plant in Canada, Victory Mills Ltd. It is also an important centre of chemurgic research



Flowsheet for synthetic rubber production from ethanol (ethyl alcohol)

The curling and drying unit for the manufacture of 'Caslen,' a casein fibre used mainly for replacing horsehair



A successful example of chemurgy is the use of seed flax fibre for making cigarette and similar fine paper

An important development of recent years is alginate rayon made from seaweed. It can be dyed with selected dyes and is non-inflammable.

Most, although not all, of the nylon, the most renowned of all the artificial fibres produced today, is manufactured by chemical synthesis from the organic products of mineral origin, but a portion is derived from furfural, which is produced from the break-down of carbohydrate materials. This chemical is attaining ever-increasing use, particularly in the plastic industry, and its production from crop residues is an important development.

Fermentation and micro organisms

There have been great developments in the production of alcohol by fermentation methods, but as these have been fully reviewed in a recent article in WORLD CROPS there is no need to do more than mention them. Of interest is the anaerobic fermentation of starchy materials to yield butanol and acetone, but today these materials are mainly produced synthetically by other branches of the chemical industry, and the process for which at one time a great future was prophesied is now of less significance.

Of other chemurgic processes in which micro-organisms take part, the production of methane gas, of glycerol and of fats may also be mentioned. The latter process has lately been given some prominence as it opened up an alternative source for a material in short supply. Up to date research has failed, however, to show a satisfactory result.

The outstanding British discovery of penicillin and the development of the manufacture of this and other antibiotics in the U.S.A. during the war should also be cited. Little has so far been accomplished in the application of these materials and methods to chemical technology, but increasing attention is being given to the matter.

The foregoing are but a few examples of recent chemurgic developments. The list could be almost indefinitely prolonged; examples which may be cited are the production of pectin from citrus wastes, wax from the press cake of the cane-sugar industry, fibre board and paper from the waste bagasse in the same industry, nicotine from tobacco waste, caffeine from the sweepings of tea factories, fat from cacao, plastics from coffee, pectose and bristle fibre from sisal waste and many others.

Chemurgy outside the U.S.A.

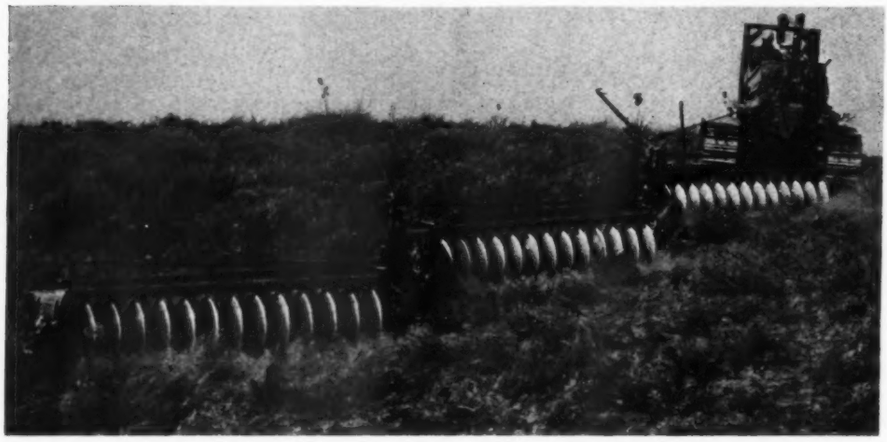
The greatest advances in chemurgy have been made in the U.S.A., but parallel advances have occurred and are occurring in many lands. In Canada the agricultural situation was similar to that in the U.S.A. A National Chemurgic Committee was formed which commissioned Dr. W. D. Macfarlane to make a 'Survey of Canadian Research on the Utilisation of Farm Products,' which was published in 1941, and developments have followed a course similar to that over the border.

In most other countries the background provided by established farming practice and farm industries is very different from the American scene. The difference is too great for chemurgy to have any effect as a definable movement. This does not mean, however, that there are not developments which are similar to the American chemurgy movement, although the word 'chemurgic' may not be in everyday use.

Thus in the United Kingdom the war gave an impetus to developments in a number of directions, owing to shortages of imported material. A notable instance was the manufacture of paper from cereal straw, a material which formerly was largely wasted.

Increasing attention has been paid of recent years to finding new uses for materials produced in the British Colonial Dependencies. New uses for rubber have

Sowing lovegrass over hilly grazing land in the south-western United States



One-way disc plough destroying most of the weedy growth prior to aerial seeding

Fifteen Years of Chemurgy—*Concluded from previous page*

been the subject of considerable research and a number have appeared, including its employment in road surfacing.

A Colonial Products Research Council has been set up, with Sir John Simonsen as Director of Research, the duties of which are to conduct investigations into possible new uses for colonial products. Among the materials on which research is in progress are citrus fruits, sugar and sugar products, starches, cocoa, vegetable oils, essential oils and natural insecticides.

Investigations on more or less parallel lines are going on in Australia, New Zealand, South Africa, India and Ceylon. Outside the British Commonwealth the subject is receiving attention in France and other European countries, while prior to and during the war many important chemurgic developments occurred in Germany.

Why chemurgy matters

It is impossible to deal in a single article with all the aspects of chemurgy. The examples cited show how very different the problems may be, and it is therefore not easy to generalise about the usefulness of chemurgy, let alone make predictions as to future developments. Nevertheless, there are two definite features common to all chemurgic industries: (1) they are based on renewable raw materials and (2) chemurgic raw materials are directly or indirectly in competition with the production of food and animal feeding stuffs.

Both points are closely linked with any discussion on the economic survival of civilised man. Chemurgists believe that they can produce from the soil all the food we need and all the material goods to which we have become accustomed. Instead of living on accumulated capital, which will be exhausted one day, man will be able to rely on his own efforts to supply his needs. To achieve this only water, air and sunshine are needed.

As a recent publication of the National Farm Chemurgic Council aptly puts it, ' The annually renewable wealth from fully utilised crops affords the world's greatest hope for producing that constantly increasing abundance which is the first essential to peace and prosperity for men and nations.'

[*Photos in this article were by courtesy of the following: p. 423, ' Philadelphia Enquirer '; p. 424 (top), Victory Mills Ltd., Toronto; p. 425 (top), ' Chemurgic Digest,' New York; p. 425 (bottom), Ecusta Paper Corporation, N.C., U.S.A.*]

Aerial Seeding Restores Pastures

Readers will remember that last month we published an account of aerial dusting of crops with fungicides from fixed-wing aircraft, carried out in the U.K., and on another page in this issue there is an article on aerial application of fertilisers in New Zealand.

In the U.S.A. the application of sprays, dusts, seeds and fertilisers from the air has been going on for some time and the accompanying photographs show another aspect of this work, namely, the restoration of pastureland that has become overgrown with sagebrush and weeds and its reseeding from the air.

Most of the weeds are first destroyed by using one-way disc ploughs; only near-level land, low dunes and low ridges are ploughed before seeding; natural vegetation is retained on land subject to erosion until grass is established. Then small aircraft cross the fields at 80-ft. intervals, usually flying less than 20 ft. above the ground, sowing the seed mixture. Lovegrass, mixed with ground milo (a variety of sorghum) to control the seed distribution, has been used and now bulkier grass seed is being mixed with the lovegrass in an effort to make a better pasture mixture. Results have shown a density of 36 seeds to the square foot on the best sown spots. This type of seeding on sandy soil in the midwestern state of Kansas has improved the land's grazing capacity and reduced the incidence of soil erosion.

It has been found that crop-dusting planes can be readily adapted for reseeding purposes.

Replacing India's Fruit

India lost valuable fruit farms to Pakistan as a result of partition, according to a report of the Indian Ministry of Agriculture. The actual percentages of the acreages of different fruits which have been lost are shown below:

	%
Peaches	47
Plums	67
Nectarines	60
Apricots	48
Strawberries	10
Pineapples	35
Quince	64

Efforts to increase fruit cultivation in Madras, Kashmir, United Provinces and Bengal are showing promising indications and it is reported that increased supplies of apples, loquats and pineapples have already appeared in consequence.

Hill Country Topdressing from the Air

P. B. LYNCH

Crop Experimentalist, Department of Agriculture, Wellington

The use of aircraft for the distribution of fertilisers and seed is gaining increasing application in many parts of the world, particularly on hilly country where the usual methods of application are difficult and economically impossible to carry out. This account of experimental aerial topdressing in New Zealand describes some of the difficulties encountered and improvements made with this promising method of application. The article is reproduced from the New Zealand Journal of Agriculture.

THE importance of hill-country pastures to the farming economy of New Zealand has rightly received increasing attention in recent years. New Zealand must 'look to the hills,' for the prosperity of the country as a whole is linked with the well-being of the hill-country farmer. And the hill-country farmer is faced with a number of difficult-to-solve problems, some of them economic, some social, but the most important concerning the land—its productivity and conservation, and reversion of its pasture cover to weeds and worthless scrub.

Topdressing with fertilisers alone will not automatically solve any one of these problems. Wholesale distribution of fertilisers from the air might even do more harm than good if the impression was formed that it would automatically result in increased production and reduced soil erosion. At the least it would be to a large degree a waste of valuable fertilisers. Topdressing must be accompanied by adequate subdivision and efficient grazing management to control the extra growth produced, and it must be carried out on a soil and on a pasture which will respond to treatment.

Most hill-country soils respond to phosphatic topdressing and many of them to lime as well. Though the liming of hills is not economically feasible in most cases, soils responsive to lime usually respond to basic slag or North African phosphates if not to superphosphate. It is possible that certain restricted areas would respond to potash fertilisers. Nitrogen deficiency is widespread, but the answer is not necessarily provided by nitrogen fertilisers but rather by the introduction or stimulation of desirable clover species in the sward.

The pastures which are topdressed must contain clovers in addition to the grasses found in hill country if a worthwhile response to fertilisers is to be obtained. If desirable clovers are lacking, their introduction by surface seeding should accompany topdressing. Though the establishment of such surface-sown clovers is by no means certain, in most cases results are sufficiently good. One of the major problems awaiting solution is the uncertain establishment of plants from the surface sowing of clover seeds, but that fact should not hinder the practice of oversowing clovers in association with topdressing.

Hand topdressing

The oldest and still the most common method of distributing fertilisers on land too steep or too broken to allow the use of machines is hand topdressing. The obvious defects of the method are that it is laborious, time-consuming and expensive. Where the productive value of the land is low the high cost of topdressing by hand is a most serious limiting factor, but even where this does not apply, labour for the work is usually inadequate. Inexperienced and careless workers far too often give a grossly uneven distribution of fertilisers. This factor cannot be evaluated accurately because it is so variable, but it is one which must lead to a large wastage of fertiliser.

There is no ready method of overcoming these defects, though efficient labour would do much to minimise them, but to cope with the expansion in hill-country topdressing which must be forthcoming if hill-country deterioration is to be arrested, it appears that alternative methods of distribution must be sought. Blower-type topdressers and aircraft provide two such alternatives.

Blower-type topdressers

The machines blow finely-divided material into the air so that it is dispersed by the wind. A method such as this, dependent on the vagaries of the wind, cannot give accurate distribution of fertiliser, but from observations in hill country it would seem to give a reasonably satisfactory spread. Recently detailed measurement trials of the spread given by these machines from a fixed point were conducted. They showed that a reasonable spread can be secured only by using finely-ground materials.

Blower-type topdressers appear to offer a useful method for hill-country topdressing, but they still require that fertiliser be transported to the farm and to fixed distribution points around the farm (say one point to every acre) and this is not always easy. The machine must also be transported about the farm. The distribution of fertiliser depends largely on the skill of the operator and the vagaries of the wind, and some material which becomes completely airborne must be wasted. However, costs of application are considerably lower than those of hand topdressing and the labour requirement is less, and no doubt an increasing number of machines will be used in future.

Light aircraft

The aerial topdressing work of the Royal New Zealand Air Force, acting through a committee of Government Departments set up by the Soil Conservation and Rivers Control Council, stimulated interest by private operators in the possibility of topdressing fertiliser materials from light aircraft, and a rapidly increasing number of operators is now undertaking this work. Detailed measurements of spread of fertiliser by this means have not yet been undertaken, but skilled pilots flying at low altitudes appear to be able to give satisfactory coverage of the ground with commercial fertilisers.

With the comparatively light loads possible—only a few hundredweight—the

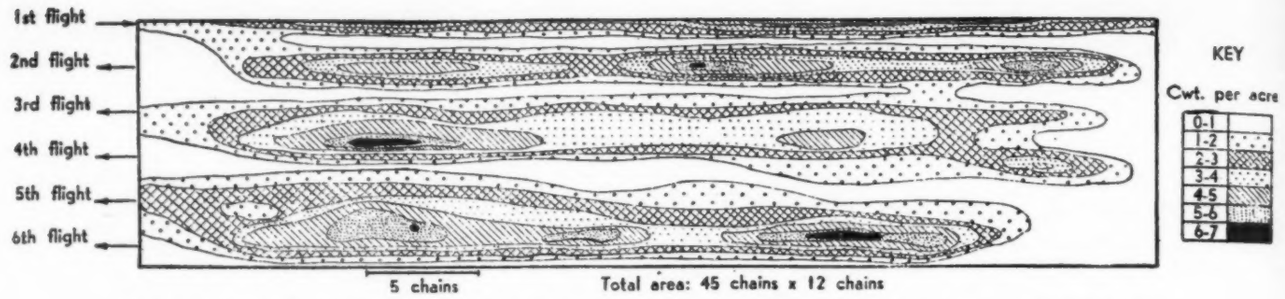


Fig. 1.—Chart showing the distribution density obtained in the trial at Ohakea, September 1949

planes must operate from a landing field close to the scene of operations, and three miles has been suggested as the maximum economic distance between the landing field and the topdressing area. This restricts the area which can be topdressed from light aircraft, for suitable landing fields are not easy to find in much of the hill country of New Zealand.

Nevertheless, the enterprise of pilots and farmers in this field is highly commendable and will do much to extend the area of hill country topdressed. Small-scale, individual paddock operations are possible, and the light aircraft can give a flexibility in time and area which is not possible with any scheme involving the use of heavy machines. However, for a national or large-scale scheme of topdressing, aeroplanes with a much larger pay-load and longer economic flying range are required.

Costs of topdressing from light aircraft are considerably lower than those of hand topdressing. At present, contract rates for a dressing of 2 cwt. per acre vary from about 7s. 6d. to 10s. per acre according to the number of days of flying weather likely in the area. Costs may even be reduced to the point at which light aircraft will be able to compete with other means of mechanical distribution on flat land.

When rate-per-acre applications are low, such as with cobalt or copper topdressing, or with surface seeding of clovers or grasses, light aircraft are entirely suitable and can operate at very low costs per acre, but when the rates required increase to more than 1 cwt. per acre the useful sphere of operations of light aircraft becomes restricted.

Heavier aircraft

Towards the end of the war interest was aroused in the possibility of using aircraft as fertiliser topdressing machines. The Soil Conservation and Rivers Control Council became interested in the project about 1947 and, working through the Inter-Departmental Advisory and Co-ordinating Committee on Aerial Distribution of Fertiliser and Seeds, arranged preliminary trials at Raglan and Ohakea in 1948. The Royal New Zealand Air Force had previously investigated the ballistic problems involved and had designed a hopper and release mechanism for the trials. For the original trials a Grumman Avenger torpedo bomber was modified by the R.N.Z.A.F., a detachable fertiliser hopper carrying about a ton of fertiliser being made from a reserve petrol tank and fitted into the bomb bay. The Department of Agriculture has been responsible for measurements of fertiliser distribution on the ground and for following up the response of the pasture to the fertilisers dropped.

Ohakea trials: September 1948

These consisted of several runs across the concrete runways of Ohakea aerodrome by the Avenger at various heights. The spread of the fertiliser was judged by sweeping up the material on the runways, the hexagonal blocks of which the runways are constructed being used as sampling units. Campbell* concluded from these trials that an aircraft flying 400 ft. above the ground and making parallel flights 90 ft. apart would apply 2 to 2¼ cwt. of fertiliser per acre.

It was found that granular material was essential, as a considerable proportion of the finer fractions of commercial superphosphate never reached the ground—at any rate, near the target area—and discharge of such material from the hopper was erratic. Such a limitation does not appear to exist with light aircraft flying, say, 50 to 100 ft. above the ground; under such conditions, particularly with a cross-wind to disperse the fertiliser, ordinary commercial superphosphate has been used to give a reasonably satisfactory distribution as far as can be judged without measurement.

Raglan trials: October 1948

This was an attempt to topdress steep hill country on the farm of the late Mr. J. B. Vowles at Te Mata, near Raglan. Unfortunately, the trial was marred by the fact that the screened superphosphate used contained a high proportion of finer particles, so that it packed in the hopper and did not flow freely during the topdressing runs. The measurements consequently revealed grossly uneven distribution, and the mean application rate was about 140 lb. per acre instead of the 2 cwt. which was the aim.

However, the trial showed that a granulated material with particles of known diameter was essential. Material which passed a ⅜-in. mesh sieve but was retained by one of ¼-in. mesh was found to be satisfactory. The hopper was redesigned with the sides set at 60° and a high-frequency vibrating rod was installed inside the hopper to obviate packing of the fertiliser and to ensure an even discharge. The trial also led to improved flight control of the aircraft from the ground and a system of two-way radio communication was devised by the Air Force for this purpose. In addition, a suitable type of seed hopper was designed and both forms of hopper were incorporated in the aircraft used in the large-scale trials in the Wairarapa.

Wairarapa trials: May 1949

A total of 120 tons of double-screened hillside superphosphate was dropped on the properties of 13 farmers, who met the cost of the fertiliser (and in some cases of seed), the cost of spreading being a charge against the Soil Conservation and Rivers Control Council. Distribution was measured by the Department of Agriculture, using special canvas catchers each collecting an area of 1 sq. yd.

Areas were selected to give a good coverage of the district and its soil types. They ranged from 50 to 80 acres each and in all cases the nature of the field made topdressing with the usual implements impossible.

Two aircraft were used and a shuttle system operated in flying the areas. The detachable fertiliser hoppers used made refilling relatively simple, and a third hop-

*D. A. Campbell: 'Preliminary Aerial Distribution Trials with Superphosphate and Seeds Mixtures,' *The New Zealand Journal of Science and Technology*, August 1948, Section A, p. 65.

per would have permitted a faster turnround of the aircraft. Ground-air two-way communication was maintained on the target areas, the ground party directing the aircraft into flight lanes and giving the signal for the release of fertiliser. Flight lanes were planned to be 2 chains apart in parallel lines across the field to be topdressed. Difficulties such as varying speeds and directions of winds and broken terrain caused modifications in the original plan from time to time.

Measurements of spread were made on six properties. In early trials distribution was not satisfactory and in some cases variations were recorded of from nil to 11 cwt. per acre within 50 yd., with a large percentage of the ground not treated. However, with improved flying technique and ground control, distribution improved markedly, and on the farm of Mr. Tatham at Homewood the spread of fertiliser over the measured area could be considered quite satisfactory and probably considerably better than is achieved in most cases with hand topdressing. The dressing aimed at was 2 cwt. per acre, and on the measured area a mean of 2.1 cwt. was recorded with a range of from nil to 5.7 cwt., but only 9 of 48 catchers gave less than 0.5 cwt. per acre.

The spread of clover seed was not determined accurately, but appeared to be considerably poorer than that of the screened superphosphate. The different densities, sizes and shapes of clover seed are reflected in a band distribution when the seed is dropped from a height, the small, light, white clover seed drifting considerably further than subterranean clover seed and falling as a band to one side of the subterranean clover. With grass seed this winnowing effect is much more pronounced. Though overlapping of runs will overcome this faulty distribution to some extent, it would appear that some form of pelleting light seed is desirable so that it falls similarly to the granules of superphosphate. The larger and heavier subterranean clover seed is much more satisfactory in this respect.

The Wairarapa trials were conducted on a large scale and clearly indicated that no mechanical or ballistic problem that could not be overcome was associated with aerial topdressing. The method of applying superphosphate was shown to be entirely practicable and, though it could not be conclusively shown because of the experimental nature of the work, the trials indicated that costs of application with aircraft more suited to the work than those used would be competitive with those of other means of distribution.

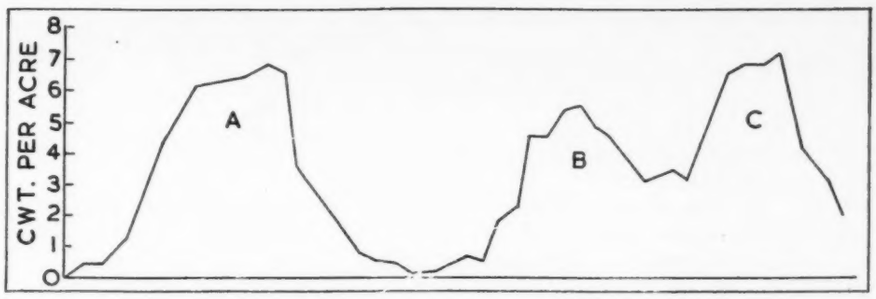
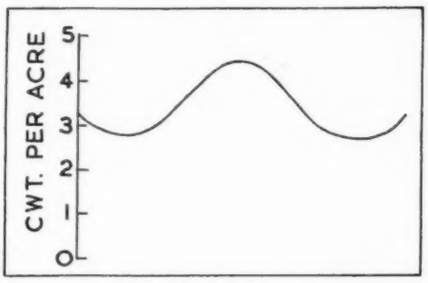


Fig. 2.—Graph showing distribution densities taken at right angles to the direction of flight



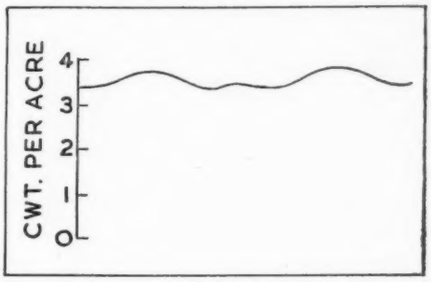


Fig. 3 (*left*).—**Graph wave resulting from fertiliser being dropped at five-sevenths of original rate and a distance of $1^3/_7$ chains between flights. Fig. 4** (*right*).—**Almost perfect distribution obtained with a dropping rate of four-sevenths of the original and distance between flights of $1^1/_7$ chains**

Detailed measurement trial, Ohakea: September 1949

The measurements of distribution of fertiliser in the Wairarapa trials were not of a type which gave a precise picture of the spread obtained, mainly because of difficulties associated with the setting up of catchers on hill country. Therefore it was decided to conduct a detailed trial on flat land at Ohakea aerodrome under good flying conditions, using skilled pilots and all the refinements in flying and ground-control technique that had been developed, together with an accurate and detailed measure of distribution. All these factors were obtained in the September trial and a detailed analysis of the results was possible. Three sets of measurements were obtained using both the special canvas catchers and the aerodrome runways as sampling units; 48 acres were topdressed.

The first set of measurements was designed to obtain the general distribution pattern and was secured with a ' grid ' of samplers. The distribution density chart (Fig. 1) shows the pattern that was obtained. A general mean density of 2.7 cwt. of fertiliser per acre fell over the sampling area. The frequency of occurrence of sampling values, excluding those on the four borders of the trial, was: 0 to 1 cwt. per acre, 25 samples; 1 to 2 cwt., 7; 2 to 3 cwt., 12; 3 to 4 cwt., 14; 4 to 5 cwt., 10; 5 to 6 cwt., 5; 6 to 7 cwt., 5; and 7 to 8 cwt., 2—a total of 80 samples. The chart shows plainly the striated pattern parallel to the direction of flight and also the tendency for the fertiliser lanes to merge in pairs on some occasions and give relatively wide gaps between the pairs of lanes. These gaps account for the high proportion of samples receiving less than 1 cwt. per acre.

The second set of measurements was taken at right-angles to the direction of flight, and Fig. 2 is a graph of the values obtained. A series of waves was expected, with the highest point of each wave corresponding with the centre of each flight lane, but it is clear that *A* in the graph represents a merging of two such waves, shown individually by *B* and *C*. Therefore, only the *B* and *C* waves were used in computing expected distribution waves. The flight lanes in this trial were 2 chains apart. Using the data from waves *B* and *C*, which were found to fit most closely to parabola, it was possible to calculate the distance apart the flight lanes should have been to get the most efficient distribution. Fig. 3 shows the wave resulting from fertiliser being dropped at five-sevenths of the original rate (which was 3.5 cwt. per acre at the point of cross-section at which the measurements were made) and a distance of $1^3/_7$ chains between flights. Fig. 4 shows the almost perfect distribution with a dropping rate of four-sevenths of the original and $1^1/_7$ chains between flights. It is clear

from this set of measurements that, with accurate flight control and the use of granular material, almost perfect distribution can be obtained with close spacing of flight lanes. The spacing to be adopted will depend on several factors, only one of which is accuracy of spread, for the closer the flight lanes the higher will be the cost of topdressing per acre.

The third set of measurements was taken along the line of flight to investigate changes in dropping rate as the fertiliser hopper emptied. These measurements showed an increase in rate from nil to 4 cwt. per acre within 190 ft. of the falling of the first particles and thereafter no suggestion of a rise or fall in rate of application, though the samples at the end of the run were blown away by the aircraft landing too close to the measuring area. There did appear to be more irregularity between weights of samples towards the end of the run, possibly indicating a more even delivery from the hopper when full than when nearly empty.

This trial showed clearly the equipment developed to date and indicated that, in reasonably weather, degree of flying skill and efficiency of ground control were the major factors causing variations in distribution. If these were perfected, practically any desired distribution could be obtained. The spread of fertilisers obtained when the aircraft flew in lanes two chains apart, though by no means perfect, was probably a great deal better than would be secured with most hand or blower topdressing.

Topdressing land with fertilisers from aircraft has been shown to be practicable and there is every chance that a rapidly increasing area will be topdressed by such means in future. No doubt for some years light aircraft will be the machines used most, and they always find a place in any aerial topdressing scheme. Eventually, however, the larger aircraft will probably assume increasing importance, especially in the back country, where haulage to the farm or to its vicinity is a large item in topdressing costs.

Rubber Research in West Java Now

The Indonesian Institute for Rubber Research has taken possession of its new building in Bogor, West Java. Courses in rubber technology are now being held in the new building for the first entry of students.

In addition the Institute is to continue its research and public information programme.

Soil Organic Matter in the Tropics

The part played by organic matter in the soil is still by no means clear, and under tropical conditions especially the evidence is conflicting. The following is a summary of a recent talk on the subject given before the annual convention of the Association of British Organic Fertilisers by Sir Harold Tempany.

IT is sad to have to confess that today our ideas on the subject of organic matter in tropical soils are less definite than they were, say, 35 years ago, and it is apparent that the sum total of what we do know is vastly exceeded by what we don't.

Modern ideas

Even in these latitudes the role of organic matter in soil economy is by no means entirely raised above the realms of controversy. It is true that the idea that the physical role of humus is to act as a sort of sponge which soaks up and holds water has been more or less abandoned. The more modern idea is that organic matter helps to maintain soil structure by giving rise to gummy substances which, working in the clay-humus complex, 'glue' the finer soil particles together to form aggregates ; also it may help the growth of moulds and other fungal organisms which entangle the particles in their hyphae.

Similarly, ideas on the microbiological changes of the organic matter and the nitrogen in the soil have undergone much desimplification. Nitrification, ammonification, nitrogen fixation and the like are no longer the simple and straight-forward processes that we formerly believed ; rather are they the resultant of unending series of microbiological wars.

The tropical aspects

The tropical aspects of the matter are particularly difficult and baffling, though this does not imply that what occurs in the tropics is entirely different from what happens under temperate conditions. The tropics are, however, the hottest parts of the earth ; winter is a very subdued affair if it takes place at all, rain comes usually in the form of torrential downpours, while the dry periods are drier and sometimes much more prolonged. Accordingly, although the factors responsible for maintaining fertility are and, in fact, must be the same as anywhere else, the way in which they work and the course they pursue may show important differences.

The net effect is that everything tends to be speeded up owing to the high temperature. Given suitable moisture conditions organic matter disappears with almost magical rapidity, and all the other soil microbiological processes are similarly accelerated. Moreover, we have to take into account accelerated erosion, unimportant in the temperate latitudes perhaps, but a potent overwhelming force when land is misused in the tropics.

Conflicting views

There is a good deal of conflict of opinion on the subject of the value of organic manures in the tropics among both planters and scientists. Take, for example, the sugar-cane planters in the West Indies. There, for more than 200 years, planting opinion held that farmyard manure is essential to maintain fertility and yields and, until recently, when artificials were given, it was as a supplement to farmyard manure. In some islands cane was grown continuously on the same land, using only farmyard manure. Of late years, however, it has been shown that artificials without farmyard manure can give equally good results, at any rate over a limited term of years. In Hawaii the cane sugar industry for the past 70 or 80 years has relied exclusively on artificials ; even the straw is removed from the land before replanting, while in British Guiana the same also holds true. It is, however, also true that in the latter country, lands so treated tend to run out after a time, although fertility can be restored by a period of flood fallowing under irrigation water. In Hawaii there may also be some evidences of deteriorating fertility on lands, which for a prolonged period have received no organic matter.

Traditional native agriculture in Africa is based on shifting cultivation which ensures long fallows under bush, often as much as 15 years or more between successive cultivations, which allow ample time for the restoration of the organic matter ; when the intervals are shortened

lands deteriorate, partly on account of induced erosion, but also for other reasons. It is held by many that humus as we understand it here may never be formed at all under tropical conditions and some authorities have suggested that organic matter may be of less moment in tropical soils than in temperate countries. This view may be exaggerated, but there is not much doubt that there are differences in the part which it plays. Such scientific evidence as is available is conflicting.

Existing evidence

In Nigeria it was found that very small dressings of farmyard manure produced significant increases in yields of crops, but it was subsequently shown that similar results followed applications of the equivalent amounts of artificials. In the Sudan on irrigated heavy sodium clay soils, dressings of artificials give equally good or better yields of cotton than do organic manures, while soils that are bare fallowed and periodically hoed to prevent the growth of weeds give better yields than soils on which weeds are allowed to grow or covers grown and bedded in. It is not a question of moisture conservation since irrigation water in sufficient quantity for the needs of the crop is available.

On the other hand, in Malaya a quartzite clay reclaimed from jungle and drained, after continuous cultivation under cassava for five years with clean weeding would not grow short-term crops such as maize or tobacco at all. When, however, dressings of farmyard manure or composted material or dried grass were given, normal crops again became possible. Complete dressings of artificials without organic matter, however, gave no response. Chinese market gardeners in the same country are wont to convert lands buried deep in infertile miningstailings into fertile soil by the liberal use of pig manure and night soil, but the same result cannot be accomplished by the use of mineral fertilisers alone.

Quite recently extensive manurial experiments in East Africa showed organic manures to give striking results in the Lake Province of Tanganyika but this was not duplicated elsewhere. Moreover green manures have given conflicting results in many places.

This shows how puzzling the organic matter question is. One point that does seem to emerge is that the decay of organic matter is much more rapid under humid than under sub-humid or semi-arid conditions and the regular addition of organic matter to the soil is more essential under the former. The crux of the matter everywhere seems to be the maintenance of the carbon/nitrogen ratio at a suitable level and this is much more likely to change rapidly under humid conditions.

There is still, however, a dearth of systematic work on the manuring of tropical work; much has been done on some plantation crops, but otherwise the gaps are enormous. Efforts are now being made to supply the deficiency; an example is the experimental work in progress in East Africa.

Organic matter is also highly important in relation to erosion control, for which the maintenance of soil structure is an essential condition; this is intimately connected with organic matter, but even in Europe the mechanism and the processes involved are still far from clear. In maintaining structure in the tropics, grasses are specially important and a system incorporating a grass ley is generally regarded as the most suitable for the sub-humid medium rainfall areas. Moreover, it seems highly probable that one of the reasons why it has been possible to grow sugar cane, itself a grass, continuously on the same land for long periods, may be that it favourably affects soil structure. The exact connection, the functions and the way things work are still obscure, but they are obviously related to the organic content of the soil.

Need for research

We have got to know more about the part which organic matter plays in the soil if we are to make full and intelligent use of the agricultural resources of the tropics. We are looking to the tropics more and more as a source from which we can draw the increasing supplies of food and raw materials which the world needs, and we must be sure that the fertility resources are conserved and not prodigally wasted. It is only by research that gaps in our knowledge can be filled and further investigations into the role of organic matter in tropical soils and its connection with other soil processes, notably the nitrogen cycle, is a major need. It must be coupled with investigations in other directions, notably on manuring of a wider range of crops and under varying conditions, as well as soil, vegetational and climatic surveys to map and classify the various soil types and to determine the types of agriculture to which they are suited. We also have to evolve systems of husbandry suited to the changing conditions and to get them applied in practice; it is only if this is done that the full potentialities of agriculture in the tropics can be achieved.

New Vegetable Crop Protectors

Plant Protection Ltd. announce that they have developed a new hormone-type chemical, ' Tuberite,' which, it is claimed, reduces sprouting of clamped potatoes by 75 to 100%. Applied in the autumn in liquid form, it permeates the whole clamp and proves effective throughout the winter and early spring until the potatoes are ready to be riddled and sacked off. The cost of applying ' Tuberite ' is about 6s. per ton.

Plant Protection in co-operation with I.C.I. have also developed a new seed dressing called Fertosan B, which, besides controlling seed growth, prevents wireworm damage. It contains the same fungicide as the original preparation ' Fernasan,' with gamma BHC added. Results of trials with ' Fernasan '-treated seed have shown increases in stand of 30 to 100%, compared with untreated seed, for a wide range of vegetable crops. Beet, radish, maize and marrow showed increases of over 100% after treatment.

This photograph, taken when the clamp was opened up, shows the contrast between untreated (*left*) and ' Tuberite ' treated potatoes (*right*)

Some Insect Pests of Tonga

THE Kingdom of Tonga forms part of the territories administered under the British High Commission for the Western Pacific. It consists of a number of small islands with a total population of 45,000. The principal crop is coconuts, copra made from which accounts for the bulk of the exports. Various tropical fruits, notably bananas and citrus fruit, are also grown, as well as a variety of food crops. Very little published literature is available concerning the insect pests of crops in this region. Last year the territory was visited by Mr. R. A. O'Connor, entomologist to the Fiji Department of Agriculture, who prepared a report on the subject, which was published in the Fiji agricultural journal, from which the following has been prepared.

Insects of the coconut palm

The coconut stick insect—*Gvaeffea crouani* (Le Guill). The eggs are laid on the ground; their incubation period is about 3 months and there are probably three nymphal stages before the insect becomes adult. Adult females are about 4 in. long and adult males about 2½ in. The colour of the adults is green or pinkish brown. The insects feed at night and rest underneath the coconut leaflets during the day.

Control consists of banding the palms with sticky bands impregnated with DDT a few feet from the ground; smoke fires are lit between the trees which cause the insects to drop to the ground and on reclimbing the trunks they become trapped on the bands.

Some degree of control is effected by the ant *Tapinoma melanocephalum*, a minute and rapidly moving species which devours the eggs.

Agonexena arguala. This small moth is found throughout Tonga; the larvae feed on coconut leaflets, usually in the lower surface. The adult is a small yellowish moth. The damage that it does is not sufficient to call for measures of artificial control and the larvae are heavily parasitised by a wasp, *Brachyneria sp.* of the family *Chalcidae*.

Diocalandra taitensis (Guer). This is a small weevil about 1/15 in. in length; the white legless grubs bore into the midribs of the fronds in the bases of the spadices and in the bracts and growing tissue of the nuts. It is not a serious pest and artificial control measures are not indicated.

Scale insects and Mealybugs, family *Coccidae*. The populations of scale insects are very small and kept low by the activities of natural enemies. The following species of *Coccidae* are found on coconut palms in Tonga:—*Phenacaspis samoana* (Doane and Ferris), *Chrysomphalus dictyospermi* (Morgan), unidentified *Diaspine* scale, *Pseudococcus cocotis* (Mask), *Icerya sychellarum* (Wesw) and *Ripersia palmarum*.

The Spike Moth—*Tirathaba trichogramma* (Meyr)—which in some places is a serious pest, occurs in Tonga, but evidence of damage caused by it is slight.

The Coconut Leaf Miner—*Promecotheca reichei* (Baly). This has been recorded, but does not cause serious damage, no doubt being controlled by native parasites.

Other insects observed on coconut palms, apart from ants, were the Sugar Cane Weevil Borer, *Rhabdoscelus obscurus* and a small weevil, thought to be *Meredolus cocotis* (Mshl).

Insects of the banana

The Banana Scab Moth—*Nacoleia octasema* (Meyr)—occurs throughout Tonga and does great damage to the banana fruit. The moth lays clusters of eggs on the unopened inflorescences and on the younger leaves of the plant. Within a few days the young caterpillars may be found feeding on the basal ' hands ' ; as the bunch develops the larvae move to the more distal ' hands ' where the bracts open later. The fully-developed larva spins a flimsy cocoon within which it pupates, often under the old leaf bases.

Control of the pest can be effected by puffing an insecticidal dust into the ' hands.' In Fiji, a mixture of pyrethrum flowers and wood ashes is commonly used, and in Samoa a mixture of lead arsenate and sulphur. Trials in Fiji indicate that DDT dust gives good control at low cost.

The Banana Weevil Borer—*Cosmipolites sordidus* (Germ)—is a pest which lays its eggs in the pseudostem near ground level; the hatched grubs bore in the tissue and heavy infestations may cause the death of suckers, greatly reducing the size of bunches and shortening the life of the plantation.

Control can be obtained by hygienic methods of agriculture. Suckers for planting should be peeled to remove eggs present, while baiting with a mixture of one part by weight of Paris Green to six parts of flour is also of use.

The predatory beetle, *Plaesius javanus* (Ev), introduced to Fiji from Java has brought about considerable control of the weevil borer there and its introduction to Tonga should have a beneficial effect.

Insects of the citrus

The fruit flies—*Dacus kirki* (Frogg) and *Dacus fascialus* (Coq)—heavily infest citrus fruit throughout Tonga. They lay their eggs on ripening fruit and the maggots bore into the fruit, converting the flesh into a slimy mass. The fruit drops to the ground and eventually the maggots emerge and pupate in the soil. As a control measure, fallen fruit should be picked up daily and destroyed by boiling or burying, while poison baits are useful.

Coccidae, **scale insects** and **mealybugs** can cause much damage, but control can be effected by spraying with white oil, one part in 40 of water.

Control of mites which can cause scabbing of citrus fruits may be effected by spraying with lime-sulphur or HETP.

Miscellaneous

The survey covers many more insects which have been found in Tonga, but they are not so important economically as those already mentioned. Scale insects, mealybugs and leafhoppers are found fairly generally on native garden crops but do not normally cause a great deal of damage, as there is a fairly good natural control by various beneficial insects. These include the larvae of a Cecidomyiid fly, which attack mealybugs on coconuts and *Pseudococcus citri* on a variety of host plants, including cacao, banana and yam; another example is the unidentified Coccinellid which preys on aphids on cacao and scale insects on frangipani.

Treated Tapioca as Rice Substitute

The problem of utilising tapioca as a substitute for rice has been successfully solved by research workers of the Government of India Food Technological Research Institute, Mysore.

Tapioca can now be treated to yield starch, which can be processed and used in the place of rice. The Institute had also perfected a tapioca-jowar combination which may be used like rice.

The Fruit Technological Institute which was functioning in Lyallpur (Punjab) prior to partition and which was subsequently closed down has now been made part of the Mysore Food Technological Institute and has commenced to function.

25 Years of Research

The Waite Agricultural Research Institute, South Australia

FOR the past 25 years the Waite Agricultural Research Institute has provided South Australia with an organisation well equipped and staffed to foster and develop the agricultural resources of the State, and the second world war did little to divert attention from the long-term problems or disrupt the even progress of the work for which the Institute was founded.

The Division of Biochemistry and General Nutrition of the Australian Council for Scientific Research maintains at the Institute a field station where certain problems on the nutrition of sheep are investigated and has made the Institute the headquarters of its Division of Soils.

Sheep and wheat, with dried fruit and wine industries, have been established in South Australia on the natural resources of the country; the Institute and its associated Council have investigated these resources in climate, soil and vegetation, enabling it to improve planting material by introduction, selection and breeding, and in methods of land management. The progress of this work is recounted in a recent report of the Institute, covering the years 1943-47* from which the following notes are largely drawn.

Climate and soils

Climatic studies have been mainly concerned with the efficiency of rainfall as modified by evaporation. Soil leaching, length of growing season, adaptability of the life cycle of insects to seasonal changes, and the search for economic plants from other countries have provided scope for climatic studies. These aspects are of particular importance in South Australia, where the annual rainfall is between about 10 and 30 in., with an annual evaporation of from 50 to 100 in. The importance of these studies is emphasised by the fact that seasonal and annual variations of rainfall are wide.

Soil surveys, in connection with climatology, have led to an increase of knowledge of the history of soils, and has proved of practical value in other directions, especially in the development of new areas.

Field crops

Among newly established crops may be mentioned flax, linseed, safflower and guayule. The main aims of field investigations, however, have been to test the influence of different crop rotations, fertilisers and cultural treatments on the yield of wheat and associated crops.

Experiments have shown that wheat-oats-pasture-fallow produce higher yields of wheat, oats and pasture than do shorter rotations. The value of field peas as a forage crop in the rotation has been demonstrated; in yield, reliability, protein value and effect on soil fertility the crop has proved to be by far the most valuable forage crop and, when grazed, increased the yield of wheat to a marked degree. The rotation, fallow-wheat-peas-pasture, gave the best resuits, and the addition of phosphate and nitrogen further emphasised the value of this rotation. In view of the value of peas in the rotation, selection and breeding work has for its object the production of early-maturing varieties suitable for districts of little rainfall.

Cereal breeding work

Field tests have served as a prelude to subsequent breeding work. New varieties of wheat have been bred and a number of varieties are now grown commercially; one is ranked as the second wheat in the State. New varieties must conform to certain minimum standards in milling and baking qualities, and a number of cross-bred varieties are being developed to produce these desirable characters. Rust (*Puccinia graminis*) and 'takeall' (*Ophiobolus graminis*) cause considerable loss of grain in a bad year. The latter disease attacks the roots and produces seedling blight or whiteheads. It is established that the fungus survives between wheat crops in the roots of certain grasses and by dormant mycelium. Using the method of back-crossing, rust-resistance derived from the variety Gabo has been transferred to other varieties, and seed stocks of ten varieties are now being built up prior to release to farmers. The same method has also been applied to the production of resistance to powdery mildew and covered smut in the popular Prior variety of barley.

Pests of stored grain

Insect pests of stored wheat have been studied over a considerable period. The results indicate that the greatest damage from weevils results when moist wheat is stored in a warm situation. A study of the rate of respiration of the different stages of *Calandra oryzae* in wheat at various moisture and temperature contents showed that great damage from weevils may result from the heat generated by the respiration of insects present in such low numbers as to be negligible from the point of view of damage to the grain.

*Report of the Waite Agricultural Research Institute, South Australia, and associated activities of the Council for Scientific and Industrial Research, 1943-47. Hassell Press, Adelaide, 1950.

Pastures

The importance of sheep-raising in South Australia justifies the intensive study of pastures which has been a feature of the work at the Institute. New herbage species and strains have been introduced, tested and incorporated in grass-legume mixtures, and the reponse of pastures to fertilisers, management, the use of water by herbage plants and the influence of pastures on soil fertility has been studied.

The introduction and testing of new species and strains of herbage plants has led to the commercial use of a number, the more important of which are *Phalaris tuberosa*, certified strains of Perennial Rye grass (*Lolium perenne*), Perennial Veldt grass (*Ehrharta calycina*), Kikuyu grass (*Pennisetum clandestinum*), Dwalganup and Bacchus Marsh subterraneum clover (*Trifolium subterraneum*), Barrel Medic (*Medicago truncatula*) and Palestine and O'Connor's Strawberry Clover (*Trifolium fragiferum*).

An annual dressing of 1 cwt. of superphosphate has been found sufficient to maintain fertility of seeded pastures of certain of these introductions. Liveweight increase and wool production of sheep grazed on unfertilised natural pasture have been as great as on pasture receiving a top dressing of phosphate and nitrogen, but the carrying capacity has been lowest on natural pasture where phosphate has been omitted, and highest on the seeded pastures.

A comparison of the effect of continuous as against rotational grazing with and without cutting for hay showed that no differences appeared as a result of rotational grazing. It was concluded that the management of livestock should not follow a rigid schedule because of the uncertainty of the seasons, the aim being to maintain pastures with a good but not excessive cover. The value of hay feeding depends on seasonal conditions; its value in one season may more than compensate for excessive costs in four years.

In areas of low rainfall, cropping with wheat in narrow rotations has led to a decline in soil fertility and to wind and soil erosion. The solution may well depend on the improvement and greater use of pasture and an attempt is being made to find suitable species and methods of establishment under these conditions. The marked influence of seasonal conditions in determining the amount and composition of available herbage for regeneration and management in arid country has emphasised the value of perennial shrubs.

Infestation with Cape tulip (*Homeria collina*) and the two-leaf Cape tulip (*H. miniata*), usually associated with low fertility and over-grazing, is widespread. Pastures comprising vigorous grass and legume species present an effective barrier to infestation. Mechanical control methods have been found effective if used when the food reserves of the plant are at a minimum and if continued systematically over a period of three years. The use of growth-inhibiting substances appears promising and hormone types of weedkillers have been successfully employed to control other types of weeds.

The improvement of pastures has brought into prominence certain insects formerly of relative unimportance. Investigations are now being directed to the ecology of these species which may lead to suggestions of modifications of farm husbandry directed to reduce the risk of damage by pests.

Chemical studies

The main subjects of recent study have included mineral deficiencies in soils, the availability of phosphorus in soils and investigations on plant viruses.

Deficiencies of trace elements in soils have been found to be responsible for crop failure in several instances. Zinc deficiency is the cause of ' die back ' of flax grown on certain dark-coloured soils. Zinc, molybdenum and potash were found to be frequently lacking for subterranean clover, while five herbage plants were found to respond to these elements and to copper. The influence of manganese and copper on plant growth was studied. The absolute amounts of these two elements rather than their ratio was the more important factor controlling growth of oats.

In many cases as little as 10% and rarely as much as 40% of superphosphate applied with a cereal crop is taken up by that crop. With repeated applications response decreases until little or none is obtained by further applications. It is concluded that when such a stage is reached, applications should be limited to maintenance of fertility. Several soil minerals have distinctive *p*H; phosphate adsorption relationships and organic matter also influence the phosphate adsorption capacity of soils.

In cultivated soils practically all the residual phosphorus remains in the inorganic form. In soils under pasture, top dressing with superphosphate leads to an increase in the organic phosphorus fraction. In cultivated soils the phosphorus fractions are distributed uniformly throughout the field, while in uncultivated fields the major portion is retained near the surface.

Plant viruses

Long-range investigations into the nature of plant viruses have been continued, emphasis being placed on the metabolic changes produced in plants as a result of infection by the viruses. The nitrogen and phosphorus metabolism of virus-infected tobacco plants (tobacco mosaic virus) has been studied. Tomato spotted wilt has also been investigated and four strains of the virus isolated. The protein-nitrogen was found to be generally higher in healthy than in unhealthy plants, though the difference was not great, but the nitrogen-phosphorus ratio of the leaf tissues of healthy plants increased throughout, whereas that of the infected plants remained consistently lower.

Growth rates in plants have been studied, and more recently growth-promoting and -regulating substances in plants have been the subject of investigation.

The report gives a concise account of the work at the Waite Agricultural Research Institute, including detailed information in tabular form and a bibliography of the published work of the Institute and of the Council for Scientific and Industrial Research. The report will repay study by those who desire a more comprehensive account of the activities of this important centre for research.

D.H.G.

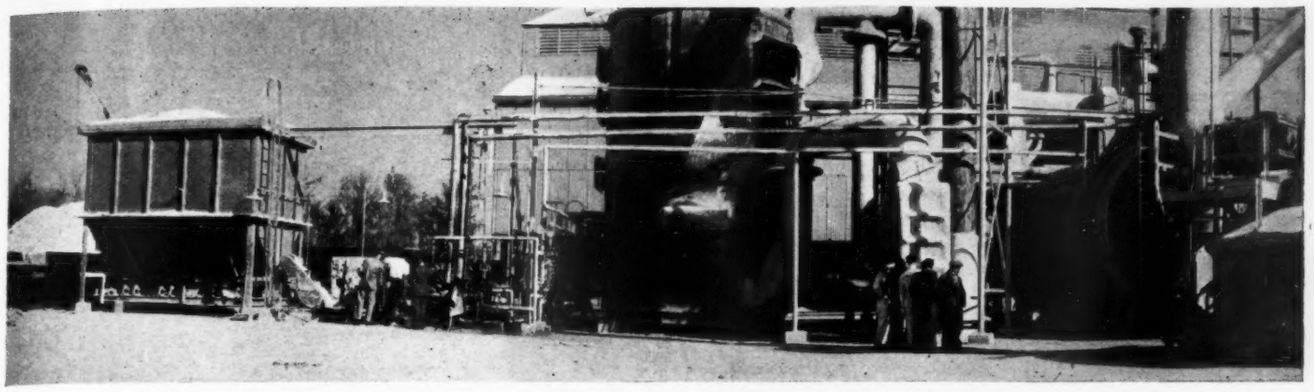
Superphosphate Makers Meet in Madrid

The International Superphosphate Manufacturers' Association held its annual series of meetings in Madrid recently, with a record attendance of some 300 delegates and members of their families, representing superphosphate manufacturers and suppliers of the raw materials of the industry from all parts of the world.

Delegates were entertained by the Spanish superphosphate manufacturers. Immediately following the meetings they proceeded to Seville, where they were entertained by the Rio Tinto and Tharsis companies, and from whence visits to the pyrites mines of these two companies were made.

Following the meetings in Madrid and Seville, a small delegation of about 40 members proceeded to Morocco, at the invitation of the Office Chérifien des Phosphates, staying three days in Marrakesh, from whence the phosphate mines at Khouribga and other places of interest were visited.

Arrangements have been made to hold the 1951 series of annual meetings of the association in Switzerland, and at the invitation of the French members, a series of technical meetings will be held in Paris in the autumn of 1951.



A contact acid plant sited in the open. The American fertiliser industry is the largest user of sulphuric acid in the country

The U.S.A. Fertiliser Industry

British Productivity Team's Report

THE report* of a visit to the U.S.A. last year by a team representing the British fertiliser industry has recently been issued by the Anglo-American Council on Productivity. It gives a picture of a highly efficient industry and makes recommendations for improving and increasing fertiliser production in the United Kingdom based upon conditions in America. The report is principally concerned with the production of superphosphate and compound fertilisers, but it also contains a considerable amount of information about the fertiliser position in the U.S.A. in general and from it the following account has been condensed.

The American picture

The American fertiliser industry differs from that of the United Kingdom in a number of respects and has certain advantages which help to keep production costs down, of which the chief is that all the raw materials required are available within the country itself and do not have to be imported. Thus large deposits of phosphatic rock exist and are mined in Florida and elsewhere, potash salts are available and are mined in New Mexico, Utah and California, nitrogenous fertilisers are produced in vast quantities synthetically from atmospheric nitrogen, while extensive sulphur deposits in Texas and California provide the material for the manufacture of sulphuric acid.

There is virtually no restriction on building and consequently it is possible to locate factories to suit the availablity of materials and to accommodate the flow of products. There has been of late years a notable tendency to manufacture fertilisers with a steadily increasing content of fertilising elements, the average content of which has risen from 18.1% in 1930 to over 20% today, and this has resulted in large savings in rail freight charges. This is particularly advantageous inasmuch as the majority of the American fertiliser plants—of which there are over 1,000 in operation—are located east of the Mississippi River and consequently freight charges to the middle and far western areas are heavy.

The total production of fertilisers has increased enormously during the last decade; thus in 1947 the total output amounted to over 18,000,000 tons, which is more than double the production in 1939, and during the last two years it has further increased. It is largely the result of the increased farm production during and since the war, coupled with the efforts of the U.S. Government to press home to farmers by all possible means the dangers of bad farming and the vital necessity of returning to the soil plant food to compensate for the amounts removed in cropping.

Forms of presentation

Much attention has been concentrated upon improving the form in which fertilisers are offered to the public. Studies on particle size, caking, moisture relationships and similar matters have resulted in the production of better-conditioned powder compounds than in the U.K. Granular forms of fertilisers are being turned out on an increasing scale and a number of plants produce granulated superphosphate.

About 70% of the total output comes on the market in the form of compounded mixtures and there are many more grades of compound fertiliser in America than in the U.K.; it is quite common, for example, for a factory to produce 20 standard mixtures in addition to special mixtures to suit the requirements of individual farmers. The latter procedure is held to lower the cost to farmers appreciably, since it eliminates much of the labour involved in handling on the farm. There is also growing interest in bulk delivery and distribution of fertilisers from factory to field.

In actual compounding the mixing units employed usually consist, as in Great Britain, of proportioning units, elevators, disintegrators, screens and rotary drum mixers. A usual addition is often an injector for ammonia solutions. Organic conditioners which assist in producing free-flowing powders are widely used. It is common practice to add ground limestone to mixtures to neutralise excess of free acid present, thereby minimising bag rot and enabling a lighter grade of bag to be used for packing.

Trace elements

Of late years great interest has become attached to the inclusion of secondary plant food and trace elements in compounded fertilisers. The former comprise calcium, magnesium and sulphur, while the latter include boron, manganese, copper and zinc. It is frequent for complete fertiliser mixtures to contain these, the formulae being varied according to the known deficiencies in the regions in which it is intended to apply them. Research by Government official agencies and by state experiment stations and agricultural col-

*Productivity Team Report, Superphosphate and Compound Fertilisers. Anglo-American Council on Productivity, 21 Tothill Street, London, S.W.1. Price 3s.

leges has enabled delineation of deficient areas throughout the country, and full advantage is being taken of the rapidly accumulating knowledge in this regard. It is a highly significant development which may be expected to spread to other countries.

Nitrogenous fertilisers

While production is mainly centred on the older standard types of nitrogenous fertiliser there is increasing interest in new and modified forms. Ammonium nitrate, which has long been known as a concentrated nitrogenous fertiliser but which until recently has been relatively little used on account of its highly hygroscopic properties and its liability to give rise to fires and explosions, is now being produced in increasing quantities, consumption having increased from 65,000 tons in 1939 to 185,000 tons in 1946. To minimise caking and moisture absorption the product comes forward in granular form, the particles of the compound being coated with 3 to 4% of diatomaceous earth and sometimes a water repellent is also added. This gives a material which stores satisfactorily, is easy to apply in the field and is relatively free from fire and explosion risks. It contains from 32.5 to 33.5% of nitrogen.

Another new type of slowly available synthetic nitrogenous fertiliser which is being developed is a product of the reaction between urea and formaldehyde which has been termed 'urea-form.' It is only sparingly soluble and nitrifies slowly in the soil; it contains about 37% of nitrogen.

Nitrogen is now fairly commonly applied in the form of ammonia dissolved in irrigation water, particularly in California and Arizona; the injection of anhydrous ammonia into the soil has recently been developed on a considerable scale and special devices for doing this are available. Another development is the application of fertiliser dissolved in water in the form of sprays, the nutrient materials being absorbed by the plants through their leaves.

Phosphatic fertilisers

Although superphosphate prepared by treating suitable phosphatic rock with sulphuric acid still accounts for a large fraction of production (the actual annual output is estimated to be in the region of 225,000 tons), great and rapidly increasing amounts of triple (or concentrated) superphosphates are now being manufactured. These are prepared by treating raw phosphates with phosphoric acid instead of with sulphuric acid, as in the older process. Considerable impetus has been given to this by the operations in the Tennessee Valley which are mentioned below.

One great advantage which the American superphosphate manufacturer enjoys compared with his British colleague, is the fact that in the U.S.A. the content of soluble phosphoric acid required by law to be present in the product is determined by the ammonium citrate solubility test, whereas in Great Britain the existing law requires that the determination must be made by the water solubility method. This has the effect of compelling British manufacturers to use greater concentrations of acid in production without producing a product which is really more efficient.

Most of the production plants are located near the phosphate deposits and one of the functions is to treat phosphatic rocks containing fluorine so as to eliminate this element and to produce defluorinated phosphates, the various forms of which include calcined phosphate, fused tricalcium phosphate and alpha phosphate.

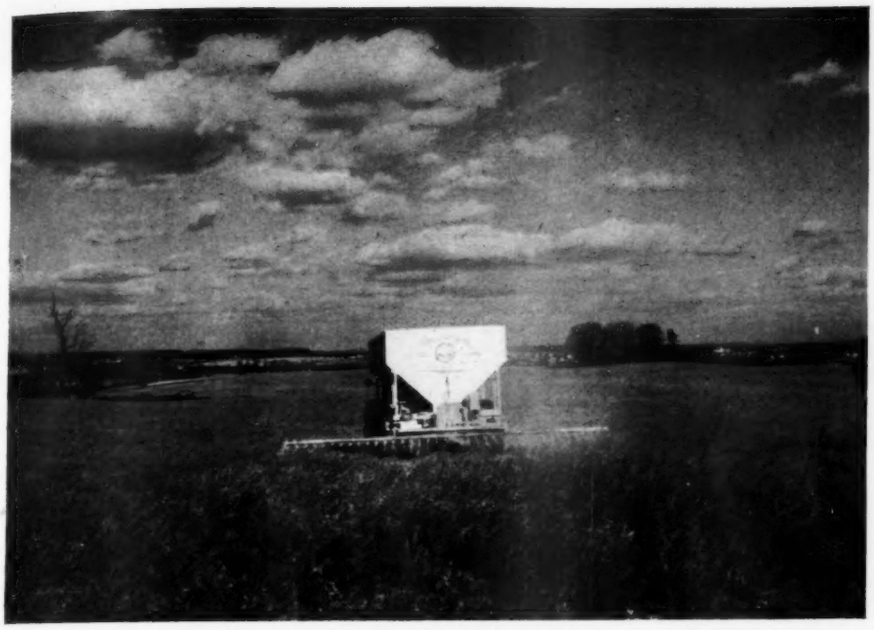
TVA phosphate production

A general description of the TVA appeared in an earlier issue of WORLD CROPS and the almost unlimited amounts of power there available have enabled a considerable number of fusion processes to be tried out. At present, however, production is mainly concentrated upon the production of elementary phosphorus from phosphatic minerals by an electric furnace method and its subsequent conversion into phosphoric acid, which is then employed in the production of concentrated superphosphate fertiliser. The following is a brief description of the process.

Phosphatic minerals, after a preliminary nodulising process, are mixed with coke and, if necessary, silica and fed to an electric furnace where the phosphate is melted and reacts with the coke to produce elementary phosphorus. The phosphorus vaporises and the vapour, mixed with carbon monoxide, is led off through the furnace off-takes, leaving a molten slag containing ferro phosphorus and other materials. These are removed periodically and sold as by-products either as agricultural liming materials or for use in steel manufacture.

The phosphorus vapour is condensed and conveyed to a burner where it is oxidised to phosphorus pentoxide, which is then hydrated to form an almost water-white solution of pure phosphoric acid of whatever strength is desired. In using this to manufacture concentrated superphosphate a simple acidulating unit is employed to ensure rapid mixing of the phosphate and the acid. The product falls into an open inverted cone fitted with four pipes through which the acid flows at a tangent to the cone's periphery. The mixed mass drops from the bottom of the cone on to a conveyor belt on which it sets as it travels forward. A second belt conveys the material to a stock pile in which it is allowed to cure before being reclaimed for dispatch.

A phosphate concentration plant showing handling equipment for transporting the finished product to the railside



From factory to field. An example of a bulk spreading service operating in the United States

Hough payloader operating in a railway box-car

Research and publicity

Although many of the larger corporations have well-equipped research laboratories, most of the investigations into the manufacture and use of fertilisers are carried out by the federal and state experiment stations and very considerable sums of money are expended annually on them.

The most notable organisation is probably the United States Department of Agriculture Laboratory and Experiment Station at Beltsville, Maryland, the main work of which comprises: (*a*) a detailed soil survey to measure plant food deficiencies in the state of Maryland and the delineation of the areas affected; (b) the development and assessment of the value of new types of fertiliser; and (*c*) the examination of methods of soil management and the encouragement of good farming techniques. The station is well equipped with laboratories and there is a considerable area under glass in which plant growth in a variety of media is being examined. Considerable work is also proceeding on the value of new types of fertiliser, *e.g.* the formaldehyde-urea compounds, phosphatic glasses and concentrated superphosphates. The use of radio-active tracers is being largely developed in investigations into the assimilation of plant food nutrients by plants and the effects of placement of fertilisers.

The American fertiliser industry supports two trade associations, the National Fertiliser Association and the Plant Food Council. They are financed by dues paid by members and assessed on the basis of tonnages of fertilisers sold. They maintain close linkage between the industry and the federal Government and hold annual conventions for discussing all matters relating to fertiliser production.

Factory layout and equipment

Availability of land in the right place and unlimited space on which to build are two great advantages which America has over the U.K. The one-block factory layout simplifies rail-siding facilities, raw material reception and finished product dispatch. Often there is a single flow-line from one end of the building to the other.

Another fairly common practice is that of having the factory floor sunk 6 or 7 ft. below ground level, with a raised platform about 4 ft. above ground level alongside the rail sidings. This reduces the overall height of the buildings and enables materials to be stored under the raised platform without much handling being required. Raw materials are almost invariably brought to the factory in bulk by rail in the standard American box-car and unloaded by mobile shovels or winch-operated drag-line scrapers. The unloading platforms are at the same level as the box-car floor and raw material is shovelled or pushed down a hopper to the storage bins below.

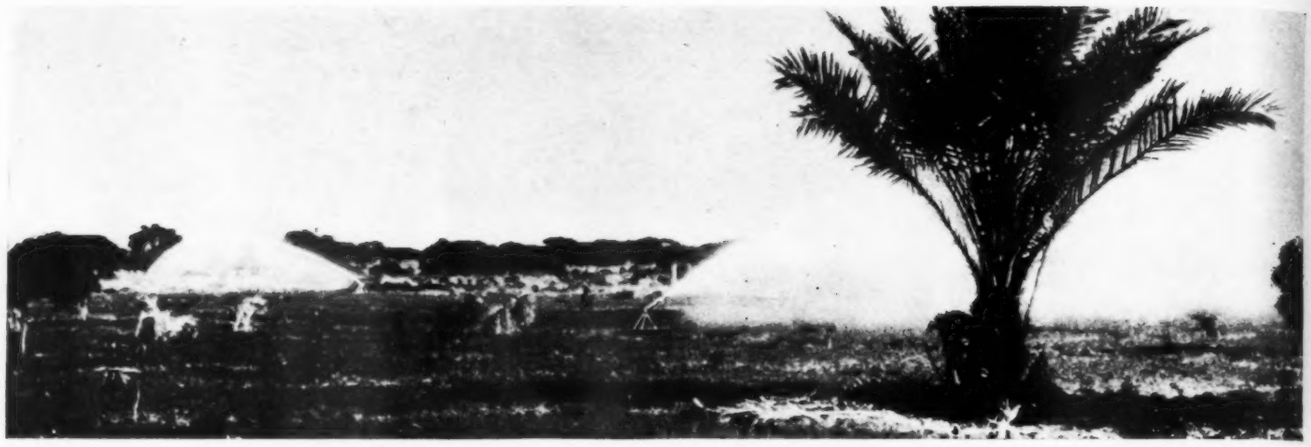
The fullest use is made of mechanical handling equipment and worm, trough, belt and bucket conveyors and elevators are employed to move materials.

Fertiliser bags are filled automatically and open-mouthed bags are invariably machine-stitched. The 100-lb. size bag is the principal type used and an interesting development is a paper bag with crepe outer ply, which makes it more resistant to mechanical damage.

Production and labour conditions

In American factories output is about twice that in Great Britain. The spirit of competition is high and wages range over a wide scale from 60 cents to $2 an hour. The American worker is much more highly paid than his British counterpart and, in spite of the higher cost of living, he has 17% more of his net earnings available for non-essential living expenses (*i.e.* expenses other than for housing, food and clothing) for bettering his standard of living.

[*Photos reproduced from the Report of the Fertiliser Productivity Team.*



Powerful rotary sprayers at work under tropical conditions

Overhead Irrigation

W. F. RIESTER, D.Sc., M.I.Mech.E.

The application of overhead irrigation to a wide variety of crops grown under many different climatic conditions has now passed its infancy and it seems likely that the practice will be extended. Combined with fertilising through the same system, the intelligent use of spray irrigation can substantially increase yields. In this article the author discusses some of the problems and potentialities of this method of irrigation.

PLANT growth depends on four main factors, *i.e.* the existence of adequate amounts of water, nutrients, air and warmth. Given ideal conditions regarding all four of these factors, crop yields could be considerably increased above the figures now looked upon as satisfactory. Over the supply of warmth and air, the farmer has relatively little control; plant nutrient and water supply are, however, largely capable of control. The separate controlled supply of fertilisers and water has today become an accomplished fact, but their inter-related use is still little understood and is rarely even appreciated by practising farmers.

All good farmers are now alive to the fact that adequate supply of water and fertilisers is essential to obtain high yields. The question still to be solved is: What is adequate? Irrigation has been practised for thousands of years, and fertilising, natural or artificial, for hundreds. Yet up to date both problems have only been attacked superficially. The study of the relations between quantities of water and quantities and types of nutrients and the best way of applying both, is still largely confined to agricultural scientists at experimental stations.

It is becoming, however, more and more apparent that irrigation is not simply a means to combat the hazards of drought, just as fertilisation should do more than prevent plant starvation. Experiments have shown again and again that more water frequently permits the use of more nutrients and consequently the growth of larger and better crops.

Maximum plant growth cannot be obtained if either moisture or nutrients or both, are limiting factors; equally, limitation of the number of plants per acre may prevent the attainment of maximum crop yields. Study of the combination of the various factors affecting plant growth and practical experiments can lead to greatly increased and improved crop yields. Overhead irrigation by itself and combined with fertilising—through the same system—intelligently used can improve yields and farming profits and repay the initial outlay within a short time.

Problems of application

The factors governing an adequate supply of water vary greatly; the kind of crops grown, the type of farming and cultivation, the character of the soil, the topography of the land, the availability of water as to quantity, quality and price, the supply of power and/or labour and, last, but not least, the climatic conditions all play their part.

Overhead irrigation is the nearest approach to rain and, though in itself this may not necessarily be a recommendation, it is the most universally applicable of all irrigation methods and requires the least preparation of the ground. It is, moreover, suited for a variety of crops, as it can be adjusted easily to varying conditions. The portable systems are relatively low in initial and running costs, though fixed installations are preferable. However, being a system consisting almost wholly of manufactured parts the initial outlay may often seem high.

Efficiency of application is, therefore, essential and this is not easy to define. One may say that water should be provided for the use of the greatest number of plants in sufficient quantity with the least possible expense in cash and labour and it has been established that overhead irrigation uses the available water with the best economy. The main query has been the evaporation losses during the passage of the water spray through the air which, it is often argued, may be appreciable, especially on hot, dry days with strong winds blowing. Theoretical calculations, applying thermodynamic principles as well as practical tests, have, however, established that these losses can hardly be more than 2%. Of course, subsequent losses by evaporation

Each rainer irrigates 1.0 to 1.6 acres. They are so placed that the radii of the spraying circles overlap each other

from wet soil and foliage will be larger than this, but those occur in other irrigation methods and evaporation from surfaces of furrows makes up the largest portion of evaporation in the overhead systems. Strong winds may be a considerable nuisance, as they tend to make the application irregular and to carry the water away to adjoining fields, but the use of a suitable type sprinkler and low application make a great difference and can often overcome the trouble almost entirely.

The main if not the only disadvantage of overhead irrigation is that sprays and dusts for pest control are liable to be washed off foliage, although even here spray irrigation has been found of use in controlling insect pests, *e.g.* red spider on hops and beans. In any case, spray irrigation may be used as a vehicle for applying chemicals for pest and weed control.

Conditions favourable to overhead irrigation

Although flood and furrow irrigation are still the most widely practised methods, it may be expected that overhead irrigation will, as time goes by, find ever-increasing application, owing to the many advantages it offers.

Its employment is particularly indicated where the following conditions apply:

(*a*) Where the quantity of water available is relatively small in comparison with the total area to be irrigated.

(*b*) On sandy, porous soils where water losses by seepage and percolation to deeper levels are liable to be considerable when water is applied by surface flooding or in furrows.

(*c*) On heavy clay soils, which can absorb water better when it is given in spray form than when it is applied by flooding.

(*d*) On uneven lands which require a considerable amount of grading to make them suitable for flooding methods.

(*e*) On shallow soils where even a minimum of levelling is liable to uncover infertile or unsuitable subsoils.

(*f*) On steeply sloping land where the rapid traverse of flood or furrow irrigation water down the slopes is liable to set up erosion.

(*g*) Where labour problems make other types of irrigation costly and unsuitable. In these conditions the more or less automatic nature of overhead irrigation makes it particularly advantageous.

The following are some of the advantages which attach to overhead irrigation:

(*a*) With overhead irrigation, valuable land is not taken up by irrigation channels, ditches, furrows, etc., and, therefore, a larger amount of ground can be cultivated.

(*b*) No preparation of ground is necessary; all that has to be done is to lay out the pipes and connect the rainers.

(*c*) It is possible to use mechanical harvesting and cultivation equipment to a larger extent as obstructing ditches, etc., are non-existent.

(*d*) The water is aerated and slightly warmed by the air, though in many instances this is not particularly important, because experience has proven that the application of cold water does not in any way harm the plants.

(*e*) No crust is formed at the top of the soil, therefore the access of air to the plant roots is not interrupted.

(*f*) Liquid fertilisers, manure, pest and weed control chemicals can be easily and automatically mixed with the water and distributed over the fields.

(*g*) Drainage problems, especially on large fields, are considerably simplified, because reversal of flow in ditches is troublesome and uncertain.

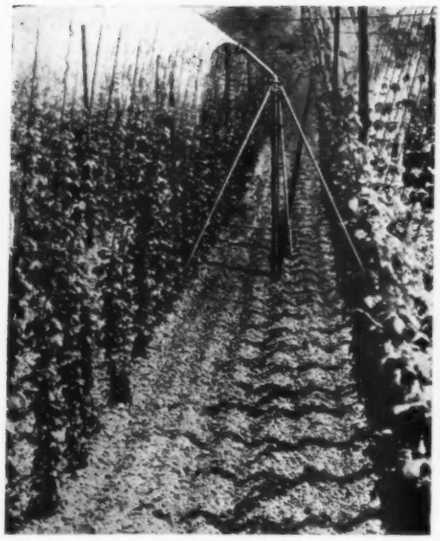
All systems of overhead irrigation take origin from the watering can and the hose pipe and, from these, present-day methods have evolved. The first development was the installation of spray lines consisting of pipes drilled at intervals which could be either stationary or movable, fixed or oscillating. Coupled with this special nozzle heads were developed, circular, quadratic and rectangular coverage being obtained by suitable arrangement of the nozzles within the nozzle head. Rotating sprinklers mounted on fixed and movable pipes were the next step and the rotating sprinkler type shows by far the greatest promise. Today the high-pressure rotary rainer dominates the position in so far as bulk crops are concerned, although for some special cases the low-pressure system seems likely to maintain its position.

Overhead irrigation is now being used on a large scale for bananas (Honduras), sugar cane (Hawaii, Cuba), sugar beet (Germany, U.S.A., England), grapes (Switzerland, France, South Africa), tobacco (Jamaica, Rhodesia), grass and alfalfa (U.S.A., Algeria, New Zealand, England), citrus fruit (Israel) and for market gardening and farming crops all over the world.

Sprinkler systems

Sprinkler systems consist of three main components: pumps, pipelines (with accessories) and rainers. The pumps mainly used are of the centrifugal type, driven by electric motors, diesel or petrol engines. Very often tractors are used to drive the pumps, either through belts or gears, the pumps being either mounted on the tractor or towed by it. In mountainous countries where static heads to be overcome are considerable, the piston pump has found favour and there are a good number of cases where static heads available are sufficient to supply the pressure to work the rainers and overcome the friction losses in the pipes.

Pipelines are made of lightweight steel or aluminium, the latter having largely replaced the former. As a rule, pipes are made 20 ft. or 30 ft. in length. Ingenious



(*Left*) **Rotary sprayer on Kentish hops, covering an area of about an acre in one position.** (*Right*) **These apples in the Western Province of South Africa have just been sprayed**

quick-acting couplings have been developed; hydrants and valves are mostly of the self-closing type, to permit quick changes in pipe lay-out without loss of water and the rapid attachment of rainers at different points of the system.

Diameters of pipes depend on the size of the system. Pipes of 2, 3, 4, 5 and 6 in. diameter are the most common, but with increasing use of aluminium the permissible sizes have gone up, and today 8 in. diameter pipes are not uncommon and there may be a demand developing for a 10 in. diameter pipe. Aluminium pipes have tremendously fostered the use of portable systems, since the light weight of the pipes makes them easily transportable. An 8 in. diameter pipe weighs only 16 lb., thus permitting easy handling by manual labour and reducing labour costs considerably.

The pressures required at the rainers vary from 30 to 100 lb./sq.in. With frictional losses in the pipelines and static heads between the source of water and the point of application, pressures in the pipe may often reach 250 lb./sq.in. and sometimes more. The strength of the pipes and joints is therefore frequently a limiting factor, although a good lay-out can often overcome this limitation.

Rainers

The rotating type of rainer is built in a variety of sizes with capacities of from a few gallons per minute at 20 lb./sq.in. pressure to about 300 gal./min. at 100 lb./sq.in. pressure. Large types can cover up to 3 acres in one rotation. With some types either circular or sector coverage is possible, the latter system enabling more economic coverage of irregularly shaped fields. A considerable amount of technical ingenuity has been applied to the design and production of rainer types, and especially to the problem of obtaining an even coverage over the whole area sprayed. These problems have now largely been solved, at any rate sufficiently for practical purposes.

Some unsolved problems

Many problems, however, remain to be solved; one of the foremost is the designing of a rainer with large area coverage and at the same time a low rate of water supply.

The most widely used types of rainer depend on nozzles operated by pressure and their use is thus limited by the laws governing the operation of nozzles. Increase in pressure is only possible if the quantities of water conveyed through the nozzle are increased at the same time; otherwise conditions of critical velocity apply and the jet is broken up and dispersed, thus preventing large area coverage.

For many applications, especially for delicate crops and certain climatic conditions, a small average supply of water per hour over a large area is essential. This cannot be achieved by existing rainer types, which, therefore, have to be operated for short intervals only, which is not only wasteful of labour and cost, but also undesirable for many crops. Especially in the tropics continuous or semi-continuous application is desirable, and automatic irrigation of the whole field during the night would be ideal. Overhead systems of an entirely different type and using different application principles may, therefore, be expected to appear in due course, although the complexity of the problem and the cost may not permit their appearance as a commercial proposition for some years to come.

For existing systems the next development likely to appear is the introduction of automatic rainer control, which will cut down the cost of labour.

Some results of overhead irrigation

Although reports of the results of overhead irrigation are still somewhat meagre there is already sufficient evidence that the expectations entertained concerning it are being fulfilled, if not exceeded. The fullest and most ample reports have come from the United States of America, where, incidentally, agricultural experiment stations have displayed great interest in the matter. In California, in particular, overhead irrigation has gained considerable extension, particularly in citrus orchards, with most satisfactory results. The beginning of the developments dates back to 1930 and since then its popularity has greatly increased.

On the continent of Europe developments started even earlier, although up to the present there are few official reports of the results. Trials have been made in Germany and Switzerland and among the most interesting are those obtained by the Agricultural Research Institute at Prague in Czechoslovakia and first published in 1936 after two years of exceptional drought. The increases recorded amounted to as much as 50% for carrots and beetroot, 66% for celery, 114% for potatoes, 100% for strawberries and 120% for pears. Increases for fodder crops—clover and grass—ranged from 100 to 150%.

More recently the New Zealand Soil Fertility Research Station has reported the results of experiments carried out during the twelve months ended April 1949, in which increased production of from 20 to 30% was recorded in the productivity of pasture land as the result of spray irrigation. The soil on which the experiments were conducted was a clay loam and the results were recorded both in terms of grass growth and sheep grazing hours.

The best results were obtained from applications at the rate of 1 to 1½ in. per watering; eight such applications were given between the third week in December and the third week in March. The measurements were controlled by plots which received no water. The irrigated area produced 7,000 lb. of dry matter per acre, while the unirrigated part produced 3,600 lb. only. It was further found that reducing the applications to ½ in. per watering greatly reduced the yield, but on the other hand increasing it to 2 in. per watering had no perceptible effect.

On the unirrigated portion growth practically ceased during the middle part of the experimental period, while on the irrigated portion growth always sufficed to carry two milking cows per acre. Moreover, the unirrigated portions became heavily infested with weed growth, but this did not occur on the irrigated parts.

In the U.S.A. equally satisfactory results have been recorded on pastures from such widely separated points as California, Texas, near Washington and in Michigan. Recently extremely satisfactory results have also been reported from the use of overhead irrigation on lucerne in Algeria.

Excellent results have further been reported from tropical countries, particularly in regard to sugar cane. The earliest experiments were reported from Hawaii, where small-scale experiments were instituted before 1930 and the first experimental results reported at the annual meeting of the Hawaiian Sugar Technologists in 1940. The rotary rainers then used were of the market garden type and the results were satisfactory, although not exceptional as compared with furrow irrigation. Since then, further trials have given more satisfactory results and it has been established that overhead irrigation can occasion a saving of water of 35% as compared with furrow irrigation. The types of rainer now being used in this class of cultivation are the largest so far manufactured and cover from 2.5 to 3.0 acres for one setting. Overhead irrigation plants have recently been, or are about to be, established in various parts of the West Indies, *e.g.* Cuba, Puerto Rico, Jamaica and Mauritius. It has been found that the best results in cane cultivation are achieved by working at night, as this overcomes the effect of wind and results in the saving of considerable amounts of water.

It seems reasonable to suppose that there is great scope for the extension of overhead irrigation in tropical countries and that it can occasion great savings in water as compared with furrow irrigation. On this account it seems not improbable that in due course overhead irrigation will become standard practice and that the water furrows which have been a feature of cultivated lands in irrigated areas for centuries will become replaced by pipelines and rotary rainers.

Soft Fruit Day at East Malling

Some of the East Malling members listening to Mr. A. F. Posnette, who talked on strawberry virus diseases

At a recent members' day at East Malling Horticultural Research Station in Kent fresh work on strawberries and raspberries was described. It appears that the matted rows system of propagation gives earlier and heavier crops of strawberries. They are produced by laying runners on fruiting beds between plants 3 ft. apart. The system saves labour in cutting runners and reduces picking time. Watering trials have shown conclusively that the strawberry crop can be increased 50 to 70% in a dry season. Cutting off leaves and firing straw after cropping have not shown conclusive results, but burnings does get rid of autumn weeds. The new strawberry varieties Perle de Prague, Climax and Early Cambridge are all doing well. The two main virus diseases of strawberry, Crinkle and Yellow-edge and their various combinations were described. Multiplication of virus-tested plants should be done under insect-proof condition followed by further propagation in isolated places to avoid the virus being carried to the plant by the strawberry aphis.

The association between raspberry cane midge and raspberry cane blight fungus was demonstrated. The midge can be controlled with benzene hexachloride (BHC) and spraying is recommended during the first and third weeks in May.

Raspberry varieties trials were shown and the merits and defects of a number of commercial varieties described. Seven new families have been bred this year and 15 others are under trial. The variety Lloyd George when virus-free is still valuable; St. Walfreid and Notable are both well-liked in Scotland. Some of the recent work on raspberry viruses in Scotland, the stock testing and propagation work in progress there was described. The raspberry aphis which has been recently found to transmit the virus diseases was described and the dipping of cane for propagation in 5% tar oil recommended.

Dwarf Sorghum

Native Agricultural Department officials in Southern Rhodesia are astounded at the result of the first experiment they have carried out with dwarf kaffir corn (sorghum). Using five different dwarf varieties, a total of 25 lb. of seed was planted at the station in the Tuli area during the last rainy season. Only 1.3 in. of rain fell after the corn was planted, yet it survived and five bags of grain were harvested.

On the west bank of the Tuli lies the Gwanda Reserve, where total yield for the season amounted to no more than a few bags.

NEW BOOKS

Manual of Rice Diseases

By G. Watts Padwick, M.Sc., Ph.D., D.Sc. Pp. viii and 198. Illustrated. Commonwealth Mycological Institute, Kew, Surrey, England. Price not stated.

The common view is to regard the pests of paddy and rice as of major importance and to relegate the diseases to a position of minor importance. This view is encouraged by the fact that pest damage is usually very evident—often spectacular—whereas, except in occasional severe outbreaks, disease damage is less obvious even though it may be more widespread. One must also admit that the entomologist has usually given the agriculturist a more definite lead than has the mycologist. In recent years, growing appreciation of the loss of crop occasioned by diseases has led to an intensification of their study, and the publication of much literature, scattered through scientific journals, some relatively unknown or inaccessible, and in diverse languages.

The task of critically examining all the literature on rice diseases has been undertaken by Dr. G. Watts Padwick. In his *Manual of Rice Diseases* he has brought the subject into perspective and provided a balanced judgment on the mass of work published over several decades.

Part I deals with diseases of parasitic origin, divided into diseases of foliage, stem and leaf sheath, seedling blights and foot rot, diseases of grain and inflorescence, and diseases caused by nematodes. Part II on non-parasitic diseases, is devoted to diseases caused by unfavourable soil conditions, deficiency diseases and virus diseases. Part III consists of a comprehensive annotated check-list of the major fungi recorded on rice, and an index.

The arrangement of subject matter is straightforward, historical summaries concise and well-balanced, while the economy of expression has made it possible to compress into less than 200 pages the essential facts covering a wide field of research. The illustrations, most of which were drawn by the author, are clear and adequate.

The author's declared aim has been to bring together the information in a form which will make a useful reference book for plant pathologists, rice breeders and agriculturists, and he disclaims any intention of providing either a textbook or a monograph. This restraint has enabled him to achieve a signal success within the compass of a volume of modest size. One may confidently predict that as a reference book it will be oft quoted, widely known, and appreciated.

D. H. GRIST

Tomato Diseases

By R. Mackay. Pp. 107. Illustrated. At the Sign of the Three Candles, Dublin, 1950, 21s.

Written because tomato growing takes such a large place in the rural economy of Ireland, this book gives guidance on the recognition and control of diseases of tomatoes. Both parasitic and non-parasitic diseases are described and illustrated, considerable attention being paid to macroscopic symptoms.

The first section is devoted to fungus diseases, of which no fewer than twelve are treated. The second section deals with bacterial diseases. The disease formerly known as bacterial stripe appears in the past to have been confused with streaking due to virus diseases, and there is now considerable question whether bacterial stripe occurs at all. In 1947 bacterial canker due to the organism *Corynebacterium michiganense* was reported and has become a special problem in Ireland.

The third section deals with virus diseases. Though common tomato mosaic (*Nicotina Virus 1*) is the most common virus affecting tomatoes in England, it does not appear to be so in Ireland. There is no cure for plants infected with any of the virus diseases and preventative measures are the only means of control.

Potatoes are often the source of the main constituent of double virus streak and, where tomatoes are grown in the open, the vicinity of potatoes must be avoided. The insect population of glasshouses should be kept as low as possible by fumigation. All plant remains at the end of a season should be burnt and the soil sterilised by formaldehyde or steam.

Fifteen irregularities are dealt with in the section on non-parasitic diseases. The first of these is classified as caused by unfavourable environmental conditions and physiological disturbances set up in the plant by the same factors. Another group comprises malnutrition and a third, chemical injury.

There are also chapters on damage due to animals and eelworms.

Having pointed out that under climatic conditions in Ireland, particularly in the more humid districts of the south and west, the control of tomato leaf mould is a difficult problem, the author deals with Vetomold, which, though liable to infection with some strains of *Cladosporium fulvum*, is very resistant to those strains of the fungus commonly encountered. From a breeder's point of view, he says, Vetomold is undoubtedly the most promising sort yet introduced. When Vetomold has been crossed with some of the good commercial varieties, certain undesirable traits appear in the second generation, but the first-generation hybrids are free from these defects, resistant to tomato leaf mould and crop reasonably well.

The volume, illustrated by photographs and including a fairly comprehensive index, is a most useful manual and a worthy successor to the same author's 'Flax Diseases,' published three years ago.

E.M.W.

Two FAO Publications

'Progress and Economic Problems in Farm Mechanisation.' Prepared by A. M. Acock of the Economics Division.

Although the term mechanisation, as applied to farming, ideally covers all types of tools and equipment from the simple digging stick to the most complex piece of power-operated machinery, this monograph deals almost exclusively with factory-built power- and animal-operated equipment. It is intended primarily to provide a broad background of factual information and some analysis of trends and problems for Government officials and others engaged in framing policies for raising the standard of agricultural methods.

The first part shows world and regional totals of tractors and draft animals in use over a period of 20 years and describes recent trends in production and international trade affecting both tractors and other farm machinery. Notwithstanding a doubling of world tractor numbers between 1930 and 1939 and again the next decade, it appears that roughly 85% of total draft power in world agriculture was still contributed by work animals in 1948. Furthermore, mechanical power is concentrated in the technically developed countries of North America, Europe, the U.S.S.R. and Oceania; all other regions of the world combined had less than 10% of the world's tractors in 1948. In general, labour-saving machinery has been introduced where wages in agriculture are high and there is a shortage of agricultural workers.

The second part of this review is a more detailed regional examination of farm

machinery in use, production, exports and imports on a country basis in the eight major regions of the world, *i.e.* North America, Europe, U.S.S.R., Latin America, Far East, Near East, Africa and Oceania. In addition some of the main related trends in the agricultural economy of each region are examined and attention drawn to some of the major obstacles standing in the way of raising the standard of farm equipment and the productivity of agricultural labour. The striking reduction in the number of workers in agriculture that has accompanied mechanisation in North America and parts of Europe is illustrated; the effect of small fragmented holdings in limiting progress is referred to in Europe, the Far East, Africa and other regions.

This monograph was prepared by A. M. Acock of the Economics Division. He had the benefit of frequent consultation with specialists in the Agriculture Division of FAO.

'Consolidation of Fragmented Agricultural Holdings.' Prepared by Sir Bernard O. Binns. FAO Agricultural Studies, No. 12, illustrated with maps.

The division of a single farm holding into scattered plots is common in many countries. Sometimes a moderate degree of such division is inevitable, harmless or even beneficial, but usually fragmentation causes diminution in the current agricultural efficiency of a holding, and hinders or prevents the introduction of improvements or of better agricultural practices. Its existence is thus highly relevant to FAO's functions of introducing new farming knowledge, improving agricultural technique, increasing production and bettering the lot of rural populations.

The first of the two parts of this study contains a general account of the cause and effects of fragmentation, of preventive or remedial measures, and of the financial implications of such measures. The second part consists of authoritative national studies of the problem contributed by four member countries: Denmark, Ireland, Switzerland and France. This method of presentation permits the inclusion of factual accounts both of actual situations and of remedial measures actually adopted, without undertaking the gigantic task of effectively summarising the world situation and without an unprofitable attempt to prescribe a procedure for prevention and remedy to fit all cases. In each selected country the problem is, or has been, vital and urgent, and is being, or has been, effectively attacked, but there are interesting differences. In Denmark the attack began long ago and has been almost completely successful; in Ireland the situation has been complicated by congestion of population on the fragmented lands; in Switzerland the mountainous terrain and the autonomy of the cantons introduced special difficulties; while France is a large country, in which, though the problem was understood and enabling legislation enacted long ago, effective attack has only been quite recent.

The monograph has been prepared by Sir Bernard O. Binns of the Land Use Branch of FAO's Agriculture Division.

Fruit Science

By N. F. Childers. Pp. 630. Illustrated. J. B. Lippincott, New York, 1949.

This book has been prepared for use in pomology courses in colleges of agriculture, but the author hopes that it will also be of use to the fruit grower anxious to master his business and desirous of keeping abreast with recent research developments. The work, consisting of 22 chapters, an appendix and an index, sets out to cover the principles and practice of the fruit industry from the establishment of an orchard to the marketing and freezing preservation of fruits, including an interesting chapter on judging contests and exhibitions.

The author has been at pains to obtain critical reviews of each chapter from leading American professional men such as Gardner, Shaw, Murmeek and Darrow; nevertheless the present reviewer can, perhaps, offer criticism and suggestion from experience gained on the European side of the Atlantic.

Since the apple is the most widely grown fruit it is dealt with first and at some length, and as the fundamental growth processes in other tree fruits are generally similar, less time is spent on them in succeeding chapters, although points of general management are stressed where these differ from the apple.

In Chapter II on 'Establishing the Fruit Planting' the English grower is immediately faced with the fundamental difference between the English and American conceptions of rootstock usage. In the mid-western states the piece root graft in apple and pear propagation is used in preference to budding; with this method the scion is whip grafted onto the roots of seedlings of either French Crab or standard American varieties. That scion rooting does occur as the graft unites and forms a tree is accepted as an advantage where the scion variety may be resistant to low temperature injury and where the seedling roots may be susceptible. In these circumstances the use of a rootstock is solely as a nurse root until such time as the scion variety can develop a satisfactory root system of its own.

The double working of certain apple and pear varieties to overcome low temperature susceptibility and incompatibility between rootstock and scion is mentioned in some detail but American workers appear not to have adopted the practice of many English nurserymen of double working in one operation, thus cutting the cost of production.

Of the pruning of apple trees a novel system developed by an Ohio grower is described. Briefly, the trees are trained into four quarters, hence the method is named 'four-leaf clover,' so that in a mature tree there are two open channels, 2 ft. wide, passing through the trees at right angles to one another. It is claimed that light is more readily admitted into the tree resulting in better growth and cropping throughout the four quarters. Spraymen find this type of tree easy for good coverage, while it is reported that over 90% fruit falls into Fancy and No. 1 grades.

The thinning of apple fruits by hand and by sprays is given one chapter and recent research work is concisely summarised. It is interesting that American fruit growers appear to have little difficulty in training their workers to thin by the leaf count method, but the retention of the centre apple (King fruit) of the cluster because it is the largest and best will not be generally accepted by English growers as suitable for their varieties.

Suggested collateral reading is listed at the end of each chapter, together with a set of review questions; the latter will be of special value to students. The work is well bound and printing errors are few, but in a second edition perhaps Table 7 could be produced on a single folded sheet instead of on two pages with poor alignment. In Fig. 86 the two plates have become transposed, while Fig. 202 has an illustration without an explanatory caption. Closer attention to the index would render the book more valuable as a reference work; for instance, pear rootstocks are indexed but not apple rootstocks, and Jonathan spot, although detailed and illustrated in the text, is not indexed. The 304 figures which illustrate the book are clear and helpful but the reviewer wonders whether the numerous plates illustrating apple displays in chain stores during apple promotion weeks could not have been replaced with advantage by more examples of the more clear-cut results from recent pomological research.

A. P. PRESTON

FARM MACHINERY

Oil-Fired Drier

A crop drier, designed in 1936 by Dr. R. E. Slade, one of Britain's authorities on grass production and conservation, is now being manufactured by Edward Curran Engineering, Ltd., of Cardiff. They have also designed an export model, oil-fired and consuming a maximum of eight gallons of gas oil per hour. Our photograph below shows the furnace on the right with the engine (or electric motor) and fan on the left ; the drying tray is in the background.

The drier is designed primarily for the small or medium farm and can be operated by one man. Hot air is drawn from the furnace, mixed with cold air entering from a secondary air inlet and passed to the perforated underside of the drying tray through a steel duct at a temperature of 220° F. ; drying temperature can be regulated. Internal dimensions of the tray are, length 16 ft., width 7 ft. and height 2 ft. 6 in.

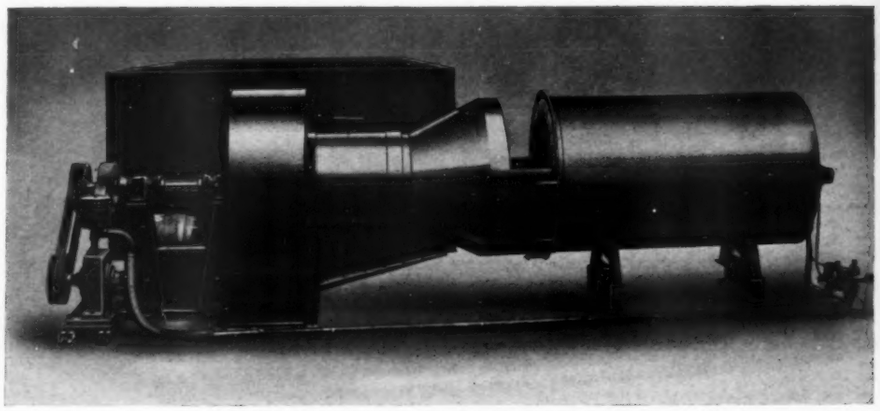
With an output of 6-7 cwt. of dried grass obtained from each batch, it is claimed that, with two batches per day, a weekly output of 3-4 tons is maintained. The machine has also been used for drying grain, seeds and wool.

10 Ton/Hour Baler

A new American twine baler, shown in the photograph above incorporates several new features in modern baler design. A ' floating ' action is obtained by means of a guide wheel on the outside of the pick-up, which keeps the pick-up fingers always the same distance from the ground. An open-end screw conveyor is used to carry crops from pick-up to the baling chamber and tension springs in the baling mechanism allow for heavy or light spots in the windrow and for moist or dry areas in the field. The bale chute throws bales to the left, away from the path of the tractor wheels on the next round.

It is claimed that the machine can pick up hay, slice it, press it and wrap it with twine at the rate of seven bales (size 16 in. x 18 in. x 36 in.) per minute or up to 10 tons an hour.

The New Holland American baler at work



The Slade-Curran grass drier

Making light work of handling free-flowing materials such as bulk grain and fertilisers this pneumatic loader can fill two waggons at once with a two-way blower spout

In many parts of Britain this year wind and rain flattened great areas of grain crops, making the work of harvesting a costly business. The use of pick-up reels on combine harvesters was a valuable aid in dealing with these laid crops and our photograph shows the latest type of Massey-Harris reel in action

Sharpening a mower blade while it is held in position on a stand, as described below

Mower Blade Grinder

An attachment, designed to speed up the job of sharpening mowing machine blades and in fact any other equipment employing a reciprocating knife, is shown in the photograph above. A lever-operated clamp holds the blade in position on a stand while it is being sharpened. The position of the knife sections in relation to the grinder is found automatically by a wheel-type spacer, and one side of two sections is sharpened before the blade is moved to the next position. Screw adjustment is provided to control the degree of sharpening required and, once set, the shaped grindstone wheel ensures sharpening to the correct taper.

Electric Hay Drying

An agricultural school near Bergen, in western Norway, is at present carrying out tests for the drying of hay by electricity. It is pointed out that electric hay drying would be particularly useful in west Norway where rainfalls are heavy and electricity relatively cheap.

The Norwegian Agricultural College has sent an engineer to Sweden, Denmark and Holland to study electric hay-drying methods in those countries. This is an example of the increasing attention that is being paid to the application of electricity on farms and the distinctive topography of Norway makes her eminently suitable for development of this kind.

The BSI Committee

Early this year the British Standards Institution announced that a Technical Committee had been appointed to devise simple, common names for well-established pest control products. They now announce that this Committee has prepared the first list of 25 common names for the better-known products in general use in agricultural and veterinary circles. This is being circulated for technical comment among Government departments, manufacturers and interested scientific societies, and in order to pre-empt the use of these names the list has been lodged with and approved by H.M. Patent Office.

Wherever possible, the names conform with those already accepted by the U.S. Department of Agriculture and it is hoped that the same measures will extend to other countries in due course.

Where possible, only the pure active ingredients have had common names assigned to them, and an endeavour has been made to avoid, with a few outstanding exceptions, the use of initials and numbers. The exceptions are compounds already known by initials, such as DDT and BHC.

Australian Cork

As a result of the New South Wales Forestry Commission's experiments, Australia may save nearly a million dollars annually in cork imports, says our Australian correspondent. Seven months ago officers of the commission found that the bark of the paper ti-tree, which grows in profusion in swamps along the coast from Victoria to Queensland, was cork, and a cork flour has been produced which is said to be identical in every way with the overseas product. ' The cost of the Australian cork will be about the same as the imported product,' says a commission spokesman. ' It is manufactured very simply. All we do is strip the bark from the tree, chip it up, dry it and then grind it into flour through a feeder mill.' Cork trees are being grown on an experimental scale in Canberra, but it takes 25 years for the first yield and, as the trees now growing are of low quality, there is not likely to be a second crop for at least another seven years.

The End of a Subsidy

The ploughing grants section of the British Ministry of Agriculture has now closed down after 11 years. In that time grants totalling £20,800,000 were paid in respect of the ploughing up of some 9,000,000 acres of grassland.

WORLD CROP REPORTS

Italian crop prospects

'Generally speaking, it can be said that the ERP scheme has been very encouraging for Italian agriculture,' reports our Italian correspondent. More farm equipment and fertilisers have enabled crop production to expand and this year's **wheat** harvest is forecast at 7,200,000 tons, compared with 6,400,000 tons' harvest last year and 6,100,000 tons the year before. Weather conditions during the harvest this year were not good and the final figure may be a little lower than the forecast.

Cultivation of **hybrid maize** has been encouraging and there seems little doubt that it will expand next year; 45,000 hectares of hybrid maize have been grown, giving an average of 0.92 ton extra per hectare over the normal Italian maize. For the farmers concerned this figure implies an extra profit of 1,500 million lire.

This year's **rice** estimate is over 600,000 tons—a great improvement on last year.

The **potato** harvest is estimated at 3,000,000 tons, 19% above last year.

The **seed broad bean** harvest has exceeded 500,000 tons and reports of **haricot beans** are good. Fresh **broad beans** totalled 148,000 tons, which is nearly 18% more than last year.

Yields of other vegetables have been: **Green peas**, 118,000 tons (up 50.4% on last year); **asparagus,** 12,400 tons (up 13.4%); **artichokes,** 157,000 tons (up 60.8%); and **onions** and **garlic,** 220,400 tons (up 18.5%).

The weather has not been very favourable for **fruit** in Italy and estimated yields are as follows:

	Tons		*Tons*
Apples ..	567,000	Plums ..	78,000
Pears ..	319,000	Almonds ..	172,500
Peaches ..	248,000	Walnuts ..	44,300
Apricots ..	22,000	Hazel nuts	23,400

Owing to continuous dry weather, predictions concerning the grape and olive harvests are not reliable, but if these crops do not receive a good deal of rain the harvest will be a poor one.

Australian vegetable yields

Details of the average acreage yield of Australian vegetables have now been released. These show the tonnage per acre to be: potatoes, 3.39; green peas, 0.68; pumpkins, 2.60; tomatoes, 4.81; french beans, 1.12; onions, 8.13; blue peas, 0.58; cabbages and brussels sprouts, 10.53; cauliflowers, 11.39; swede and white turnips, 4.30; carrots, 6.44; navy beans, 0.18.

More Canadian linseed

Canadian linseed acreage for 1950, forecast at 541,000 acres, is an increase of 68% over the final estimate of 322,500 acres for last season but a decrease of almost 60% from the 1944-48 average.

Condition of the linseed crop for all Canada indicated a yield of 6.86 bushels/acre. On this basis, 1950 production should be about 3.7 million bushels. A crop of this size would not meet Canada's domestic requirements, but stocks should be sufficient to supply the deficit and possibly to provide an exportable surplus.

Egyptian cotton forecast

The first official forecast places Egypt's 1950-51 cotton acreage at 2,049,000 acres, compared with a first estimate of 1,747,000 acres for 1949-50 and a final estimate of 1,756,000 acres. Production is estimated by private sources at about 2,050,000 bales (of 500 lb. gross weight). The estimated increase in acreage over last year's final estimate was distributed as follows: 8% in lower Egypt, 21% in middle Egypt and 51% in upper Egypt.

Brazil's record cocoa crop

Brazil harvested the largest cocoa crop in its history in the 1949-50 crop year (April to March), according to the American Consulate in Bahia. The total 1949-50 output of 355 million lb. exceeded the previous record production of 335 million lb. in 1946-47 by 6%. Brazil produced 276 million lb. of cocoa in 1948-49 and an annual average of 264 million lb. in the pre-war (1935-39) period.

Since Brazil's domestic consumption of cocoa beans now amounts to about 40 million lb. annually, the 1949-50 output provided about 315 million lb. for export.

While the Bahia Cocoa Trade Commission continues to estimate the Bahia May to September 1950 intermediate crop at about 80 million lb., trade sources in Brazil expect it to reach about 100 million lb. Weather conditions so far have been favourable for the main crop to be harvested from October 1950 to January 1951.

Indian tea exports for 1950-51

During the year 1950-51, 435,307,713 lb. of tea are to be released for export, the Indian Government have decided. This figure is 25% above India's standard export figure.

Record Mauritius sugar crop

Production of sugar in the island of Mauritius for the 1949-50 crop year was 415,969 metric tons, constituting a record, of which 396,938 tons were exported. Average results, compared with the previous year, were as follows:

	1949-50	1948-49
Sugar cane sucrose, % ..	14.33	14.31
Bagasse, % of cane ..	23.9	23.9
Total sugar extracted as % of cane	12.39	12.42
Polarisation	98.4°	98.4°
Number of milling days ..	113	111
Tons of cane crushed per hour	51.2	48.6
Milling hours per day ..	19.8	19.4

Crushing of the 1950-51 crop began on June 26 and the official crop estimate was given as 433,000 tons. Weather conditions have been good this year.

June 4 returns

The total acreage of crops and grass (excluding rough grazing) in England and Wales, according to this year's June 4 returns, shows a very slight increase over the total for the same time last year, from 24,380,000 to 24,440,000. The wheat acreage has increased from 1,899,000 to 2,395,000, while barley and oats have fallen from 1,885,000 to 1,625,000 and 1,946,000 to 1,835,000 respectively. Returns for some of the other crops and grass are listed below:

	('000 *acres*) *June* 1949	*June* 1950 (*provisional*)
Mixed corn	670	824
Potatoes, first earlies, second earlies and maincrop ..	929	867
Sugar beet	413	419
Linseed	58	38
Flax, for fibre	17	17
Vegetables for human consumption (excluding potatoes), crops under glass and flowers, grown primarily for sale	538	513
Temporary grass	3,696	3,549
Permanent grass:		
For mowing	2,634	2,755
For grazing	1,376	1,381

World rice prospects

Although the expected need for shipping large quantities of rice to Korea for the relief of its people is not likely to result in serious shortages for other areas, rice-consuming nations must plan their requirements carefully to avoid hardships for other rice importers, according to the UN Food and Agricultural Organisation.

The FAO summary said that, 'in general, world rice production is about back to pre-war, with increased areas and yields in India, partial crop failure in China, and bumper crops in the Western Hemisphere.'